REPORT OF THE PROCEEDINGS

OF THE

TWENTY-SECOND ANNUAL CONVENTION

OF THE

American Railway Master Mechanics' Association,

HELD AT

NIAGARA FALLS, N. Y.

JUNE 18th, 19th AND 20th, 1889.

EDITED BY ANGUS SINCLAIR, SECRETARY.

CHICAGO:
R. R. DONNELLEY & SONS, PRINTERS,
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AMERICAN RAILWAY

MASTER MECHANICS' ASSOCIATION.

OFFICERS FOR 1889-90.

PRESIDENT.

R. H. BRIGGS,

Memphis, Tenn.

FIRST VICE-PRESIDENT.

JOHN MACKENZIE,

Cleveland, Ohio.

SECOND VICE-PRESIDENT.

ALBERT GRIGGS,

Providence, R. I.

TREASURER.

O. STEWART,

Charlestown, Mass.

SECRETARY.

ANGUS SINCLAIR,

New York.

PROCEEDINGS.

PRELIMINARY.

THE TWENTY-SECOND Annual Convention of the American Railway Master Mechanics' Association was held at Niagara Falls, N. Y., on June 18th, 19th and 20th, 1889, President Setchel in the chair.

President Setchel called the meeting to order on June 18th at 10:25 A. M.

The Rev. C. S. Stowitts, of the First Presbyterian Church of Niagara Falls, opened the proceedings with prayer.

Mr. H. J. Sheldon, President of the Village of Niagara Falls, delivered an address of welcome.

ROLL CALL.

Secretary Sinclair called the roll. The following members were presen then, or at a later session:

THOMAS ALDCORN............West Shore, New Durham, N. J.
W. C. ARP......................C. St. L. & P., Logansport, Ind.
W. AUGUSTUS...................Keokuk & Western, Centerville, Ia.
J. DAVIS BARNETT............Grand Trunk, Stratford, Ont.
JOHN BEAN.....................Cleveland & Canton, Canton, O.
JOHN BISSET....................W. W. C. & A. Wilmington, N. C.
CHARLES BLACKWELL........Philadelphia, Pa.
J. M. BOON......................West Shore, Frankfort, N. Y.
S. D. BRADLEY.................G. R. & Ind., Grand Rapids, Mich.
R. H. BRIGGS....................K. C., M. & B., Memphis, Tenn.
F. R. F. BROWN...............Canadian Pacific, Montreal, Que.
H. S. BRYAN....................St. Paul, Minn.
R. W. BUSHNELL..............B., C. R. & N., Cedar Rapids, Ia.
JOHN CAMPBELL..............Lehigh Valley, Delano, Pa.
N. E. CHAPMAN...............Philadelphia, Pa.
DAVID CLARK..................Lehigh Valley, Hazelton, Pa.

JNO. W. CLOUD	Buffalo, N. Y.
ALLEN COOKE	C. & E. Illinois, Danville, Ill.
JOHN S. COOK	Georgia, Augusta, Ga.
C. H. CORY	C. H. & Dayton, Lima, O.
J. P. DICKSON	Dickson Locomotive Works, Scranton, Pa.
D. J. DURRELL	Rotary Snow Shovel Co., Paterson, N. J.
W. H. EDDY	Boston & Albany, Springfield, Mass.
W. C. ENNIS	N. Y., S. & W., Wortendyke, N. J.
G. W. ETTENGER	Iron Car Co., New York.
D. T. EVARTS	Boston, Mass.
A. FENWICK	G. B., W. & St. P., Green Bay, Wis.
G. A. FERGUSON	Lake Village, N. H.
Z. J. FERGUSON	Mobile & Ohio, Jackson, Tenn.
F. J. FERRY	L., St. L. & Texas, Henderson, Ky.
T. A. FRASER	M. S. S. M. & A., Minneapolis, Minn.
WM. FULLER	213 Kennard St., Cleveland, O.
T. W. GENTRY	Richmond & Danville, Manchester, Vt.
W. GARSTANG	Ches. & Ohio, Manchester, Pa.
CHARLES GRAHAM	D., L. & Western, Scranton, Pa.
J. S. GRAHAM	L. S. & M. Southern, Cleveland, O.
FRED B. GRIFFITHS	D., L. & Western, Buffalo, N. Y.
ALBERT GRIGGS	P. & Worcester, Providence, R. I.
CLEM. HACKNEY	Milwaukee, Wis.
GEORGE HACKNEY	Chicago, Ill.
B. R. HARDING	R. G., R. & A. Raleigh, N. C.
T. A. HATSWELL	F. & P. M., East Saginaw, Mich.
WM. HASSMAN	R. & Alleghany, Richmond, Va.
JOHN HEWITT	Wabash Western, Butler, Ind.
JOHN HICKEY	M., L. S. & W., Kaukauna, Wis.
M. L. HINMAN	Brooks Locomotive Works, Dunkirk, N.Y.
S. A. HODGMAN	Lobdell Car Wheel Co., Wilmington, Del.
E. W. M. HUGHES	Fox Solid Steel Truck Co., Chicago, Ill.
O. H. JACKSON	O. & Miss., Vincennes, Ind.
G. R. JOUGHINS	Erie & Huron, Chatham, Ont.
SANFORD KEELER	F. & P. Marquette, East Saginaw, Mich.
C. F. LAPE	Wabash, Springfield, Ill.
J. K. LAPE	St. J., St. L. & S. F., St. Joseph, Mo.
J. N. LAUDER	Old Colony, Boston, Mass.
L. F. LYNE	Jersey City, N. J.
JACOB LOSEY	Steam Forge Company, Louisville, Ky.
JOHN MACKENZIE	N. Y. C. & St. L., Cleveland, O.
JAMES MACBETH	West Shore, Buffalo, N. Y.
J. S. McCRUM	K. C., Ft. S. & G., Kansas City, Mo.
JAMES MAGLENN	Carolina Central, Laurenburg, N. C.
JOHN McKENNA	I., D. & S., Indianapolis, Ind.

JOHN MEDWAY....................Fitchburg, Mechanicsville, N. Y.
JAMES MEEHAN..................C. N. O. & T. P., Ludlow, Ky.
THOMAS MILLEN................N. Y. City & Northern, High Bridge, N. Y.
WM. MONTGOMERY...........Cent. of New Jersey, Manchester, N. J.
J. E. MORRELL....................C., R. I. & P., Davenport, Ia.
J. H. MURPHY......................N. Y., L. E. & W., Buffalo, N. Y.
L. C. NOBLE.........................H. & T. Central, Houston, Tex.
J. S. PATTERSON..................Cincinnati, O.
L. B. PAXON..........................Phil. & Reading, Reading, Pa.
PETER H. PECK....................C. & W. Indiana, Chicago, Ill.
J. E. PHELAN.........................Northern Pacific, Mandan, Dak.
A. J. PITKIN..........................Schenectady Locomotive Works, Schenectady, N. Y.
JOSEPH S. PORTER..............C., S. & C., Sandusky, O.
G. H. PRESCOTT..................T. H., I. & St. L., Terra Haute, Ind.
T. B. PURVIS.........................Boston & Albany, East Albany, N. Y.
L. S. RANDOLPH...................Cum. & Penna., Mt. Savage, Ind.
GEO. RICHARDS...................Roxbury, Mass.
E. RICHARDSON....................S. & Alleghany, Shenango, Pa.
E. M. ROBERTS......................A., C. & I. Co., Ashland, Ky.
GEO. B. ROSS.........................Buffalo, N. Y.
J. H. SETCHEL......................Pittsburgh Locomotive Works, Allegheny, Pa.
W. A. SHORT..........................O. & L. C., Malone, N. Y.
ANGUS SINCLAIR...................Morse Building, New York, N. Y.
W. T. SMALL...........................Northern Pacific, St. Paul, Minn.
C. E. SMART..........................Michigan Central, Jackson, Mich.
W. T. SMITH...........................N. N. & Miss. Val., Lexington, Ky.
H. N. SPRAGUE......................Porter Locomotive Works, Pittsburg, Pa.
S. A. STEPHENS.....................Rhode Island Locomotive Works, Providence, R. I.
O. STEWART...........................Fitchburg, Charlestown, Mass.
F. A. STINARD........................Pompton Junction, N. J.
W. A. STONE..........................L. E. & St. L., Huntingburg, Ind.
WM. SWANSTON....................C., St. L. & P., Indianapolis, Ind.
H. TANDY...............................N. Y., O. & W., Middletown, N. Y.
THOS. THATCHER..................D., L. & W., Utica, N. Y.
W. H. THOMAS.......................E., T., V. & Ga., Knoxville, Tenn.
S. B. TINKER..........................C., W. & Mich., Wabash, Ind.
W. F. TURRELL......................C., C., C. & I., Cleveland, O.
T. B. TWOMBLY......................C., R. I. & P., Chicago, Ill.
C. W. WALKER.......................S. & Roanoke, Portsmouth, Va.
AMOS H. WATTS....................Cincinnati, O.
REUBEN WELLS.....................Roger Locomotive Works, Paterson, N.J.

G. W. WEST .... N. Y., L. E. & W., Jersey City, N. J.
M. C. WHEELER .... Central Iowa, Marshalltown, Ia.
D. A. WIGHTMAN .... Pittsburgh Locomotive Works, Alleghany, Pa.
JOHN WILSON .... Union Pacific, Omaha, Neb.

The following new members joined the Association at this convention:

A. W. BALL .... N. Y., P. & O. Galion, O.
J. N. BARR .... C., M. & St. P. Milwaukee, Wis.
J. E. BATTYE .... Shenandoah Valley, Milnes, Va.
WM. R. BILLINGS .... Taunton Locomotive Works, Taunton, Mass.
JOSEPH BRADT .... N. Y., L. E. & W., Rochester, N. Y.
T. CARMODY .... N. Y., P. & O., Cleveland, O.
PETER CURRAN .... N. Y., L. E. & W., Bradford, Pa.
ALONZO DOLBEER .... B., R. & P., Rochester, N. Y.
GEORGE GIBBS .... C., M. & St. P., Milwaukee, Wis.
F. A. GIVAN .... Ches. & Ohio, Huntington, W. Va.
J. L. GREATSINGER .... D., I. & R., Two Harbors, Mich.
S. H. HARRINGTON .... N. Y., L. E. & W., Susquehanna, Pa.
S. HIGGINS .... N. Y., P. & O., Meadville, Pa.
W. J. HALLER .... Ches. & Ohio, Richmond, Va.
W. LAVERY .... N. Y., L. E. & W., Susquehanna, Pa.
W. H. LEWIS .... Ch., B. & North, La Crosse, Wis.
E. A. MILLER .... N. Y., C. & St. L., Conneaut, O.
J. H. MOORE .... N. Y., L. E. & W., Port Jervis, N. J.
J. C. RAMSAY .... Miss. & Tenn., Memphis, Tenn.
T. W. RANSOM .... N. Y., L. E. & W., Hornellsville, N. Y.
JOHN ROBINSON .... L. S. & M. S., Buffalo, N. Y.
H. M. C. SKINNER .... N. Y. Locomotive Works, Rome, N. Y.
WM. J. THOMAS .... Nor. Pacific Coast, Sausalite, Cal.
CHAS. C. TURNER .... W. N. Y. & Penn., Olean, N. Y.
L. H. TURNER .... Pitt. & L. Erie, Chartiers, Pa.
S. R. TUGGLE .... Kentucky Central, Covington, Ky.
ALLEN VAIL .... W. N. Y. & Pa., Buffalo, N. Y.

THE PRESIDENT.—It is customary at this stage of the proceedings to give an opportunity for the admission of new members, Our new Constitution adopted last year provides for the making out of an application, but as we have hardly yet got to work under that arrangement, the usual form will be pursued to-day and blanks will be furnished and the applications made out in proper form some time during this Convention. Now we will have a recess of five minutes. All those persons knowing themselves to be eligible to membership can come forward and sign the roll of membership. The Secretary has a statement which he desires to make at this time.

SECRETARY SINCLAIR.—It very often happens at these conventions that

members come in after the roll has been called and their names do not appear in the annual report or in the papers publishing these proceedings, and when they fail to see their names there they are nearly always disappointed about it. I think it would be very desirable if any of you who have friends arriving late would see that they notified the Secretary, so that their names may be placed on the roll, and it will save a good deal of disappointment later on in the year.

A recess of five minutes was then taken.

THE PRESIDENT.—Gentlemen, it has been our custom to have the article regulating the admission of new members read. I will ask the Secretary to read the article on the subject.

THE PRESIDENT.—Gentlemen: I hold in my hand the minutes of the proceedings of the last annual meeting. It has been customary to approve them without reading. What is your pleasure in regard to them?

On motion of Mr. R. H. Briggs it was agreed that the minutes, as printed, be approved without reading.

PRESIDENT'S ADDRESS.

President Setchel then delivered the following address:

LADIES AND GENTLEMEN: Again we meet in convention, and again it is my pleasant duty to address to you such words of welcome and encouragement as may seem fitting for the occasion.

At our last annual meeting we took the opportunity to try and show that the principle and object of the association was not so much to establish mechanical standards as to promote investigation of mechanical questions; and those of you who were present or who have since read the president's address, and have watched the interest taken in the formation of new railway clubs in all prominent railroad centers for the discussion of such questions, will, we think, admit that the position there taken has been fully sustained; for these organizations are but the outgrowth of this and kindred associations.

The chairmen of committee in the larger association very wisely take pains to have the subjects upon which they are to report introduced and discussed in the local clubs, that full information may be obtained for presentation at these annual gatherings. And without any disparagement to the plan of committee circulars and answers, we may say that the information thus obtained is of a far different character from that in the average answer to a committee circular. In the one case you have the limited practice, with, perhaps, the theory as to probable results; in

the other you have a summary of experience that largely proves the result. Indeed. so valuable have the proceedings of these clubs become that they form a large part of the technical reading on current mechanical topics of the day in the best papers of the country. And in the selection of such reading matter the press simply gives the public what it asks for—a summary of what is regarded as the latest and best practice in railway mechanics.

But it is a notable fact that sometimes what seems the best is faulty, and remains so for an indefinite length of time; but this does not come from an intelligent investigation of the subject, but rather from lack of such investigation. We do not know where we stand until we compare ourselves with our neighbors. Who has not been sitting in a railway train and imagined that a train on an adjoining track was standing still, while his own was moving, until, casting his eye upon the ground, the delusion is suddenly dispelled, and we find that we are standing still and our neighbor is the one that is moving. So it is oft times in mechanics. We think we have the best, we are moving, but by comparing ourselves with others, we find to our dismay that it is the other fellow that is moving and that we are fast falling to the rear.

As an illustration of the evolution of the locomotive in certain directions of construction and operating under association influence, let us take a few familiar examples.

We all remember how, in the early days of railroading, we used to throw away cylinders because of the valve seat being badly worn, and then how to obviate this we contrived to put on a false seat by using a large number of tap bolts that made an expensive job to begin with and often more so to maintain. Engines would frequently give out on the road and trains would be delayed from the false seats becoming loose; and the matter continued to receive the earnest attention of master mechanics until it was discovered that, really, these false seats required no fastenings at all, and a patent was actually obtained for this discovery. But only a little later on it was also discovered that the balanced valve would not only obviate the necessity for renewing cylinders or applying false seats, but would also enable the locomotive to do much more work with less wear upon the valve gearing, and this is now being generally adopted. In direct connection with this

subject came that of lubrication for valves and cylinders. The time when no lubricant was used for locomotive cylinders and valves, has been handed down to us by some of the older members, but the transition from the tallow-pot to the nicely adjusted sight-feed lubricator of the present is of so recent a date as to be remembered by all, and the benefits derived from these two improvements alone can scarcely be measured.

With the improved method for lubricating cylinders came the opportunity to cheapen the lubricator itself, and, instead of tallow and lard oil, at one and two dollars per gallon, we now use a lubricant, made by many of our leading railways, costing less than thirty-five cents per gallon, and that works well in our sight-feed cups and gives better results in the cylinders than the expensive material of a few years ago.

The hemp packing, in general use but a short time for pistons and valve-stems, is fast giving away to the much better metallic packing. The old-style piston-packing, with its expensive rings and springs, is replaced with the simple snap-ring and cast-iron heads.

The record of steel boiler plate, from the early days of coal-burning locomotives, when sixty per cent. of the steel fire boxes fractured within a very short time after being put in service, to the steel that now lasts from five to twelve years, and from the boiler of 120 pounds steam pressure to that of 180 pounds of the present, is the history of this association. Never has it failed to have this subject under consideration, and each of the improvements named has year after year received the careful attention of committees. The defect of the present and the necessity for better service have been clearly outlined and the improvements made have been at the demand of the Master Mechanics' Association—thus doing for the railroads what individuals could not do, by collecting and presenting to them the combined experiences of railway mechanics as to the best material and the practice of constructing it in the best possible manner.

What we have mentioned are but a very few of the many improvements that have been made as the result of the persistent investigations of this association. Much more might be said of what has been accomplished, but as with every effort to obtain knowl-

edge new possibilities are constantly presenting themselves, until what has been done seems but a drop in the bucket, and we turn our attention to new subjects and to what there is new in new subjects that pertain to the live future of railway mechanics.

The subjects that will be presented for your consideration at this convention are important and will deserve, as they no doubt will receive your very careful consideration.

The first to be presented—"the purification of feed waters for locomotives "—is a subject that has occupied the attention of the association since its first organization. It is one that is closely connected with the life of the fire-box and boiler and the durability of the locomotive itself. It sometimes seems a debatable question as to whether the steel we now use in boilers is so improved in quality or whether it is the improved quality of the feed-water that has more than doubled the life of our locomotive boilers, while performing a largely increased amount of work. The purity of the feed-water largely affects the consumption of fuel, the one great question in railway mechanical economy that overtops all others and one which this association is in duty bound to follow up to a termination of better results.

"The thickness of tire as affecting their durability" will be an interesting subject, and will have advocates on both sides, and full discussion of the question can not fail to produce good results.

This will be followed by the subject of "exhaust nozzles," which is one that, while it is often lightly regarded by some, continues to receive the attention of our best mechanics—a number of whom have made radical departures from the usual practice during the year, and some of which give promise of good results, both in the working of the engine and also in the amount of fuel consumed by giving better combustion.

The subject of "driving boxes" is fourth in the list and has frequently been before you for consideration, but there still exists a variety of opinion as to the best metal for driving boxes as well as the best shape and method of fitting up. A number of good mechanics have used solid brass driving boxes and claim that—while it is expensive in first cost—the durability and great length of service these boxes give, and the fact that the old metal is worth

nearly its full value when the box is worn out, more than compensate for the increased first cost. Under this head your committee will, no doubt, consider the subject of lateral motion for driving and truck boxes, as there seems to be an opinion prevailing among some of our best mechanics that this work is being fitted up too close.

The fifth question of "boiler covering," the seventh the "best proportion of grate and flue area," and the ninth, "water space around fire boxes and flues," all point to and have more or less to do with the fuel question.

We must get a larger percentage of the heat from our fuel and as far as possible prevent any unnecessary radiation.

The eighth question, which includes a suitable form of mud rings and method of fastening, is but little behind those we have mentioned in its influence on fuel. All leaks in fire box or boiler detract from its steaming qualities, and no part leaks so often or continues so long as the mud ring of the fire box.

The questions are all important, and if full justice is done them in discussion, this will be a busy convention.

BOSTON FUND.

At our last annual meeting you will remember we adopted a new constitution and by-laws which will govern the deliberations of this body.

Under the provisions of this instrument the writer was unanimously appointed custodian of the Boston fund. This you will see by referring to last report consisted of a principal in 4 per cent. government bonds.

Boston fund, principal	$6,200.00
Interest for same in present year	248.00
Interest remaining over for last year	22.13

Leaving a balance of uninvested interest of .... $270.13.

This will be invested as may be directed by the executive committee.

Notice was given last convention of an amendment to be offered at this time in regard to nomination of officers. There should also be notice given at the proper time of an amendment

fixing the amount of initiation fee for new members, as this has been omitted entirely in the new constitution.

With characteristic energy the secretary had the reports printed and distributed to members early in the year. A reprint has also been made of the fourth annual report, which is now ready for distribution.

There has been a large contribution to our printing fund, and our financial condition is exceedingly good.

For a detailed report of the above you are respectfully referred to the full and able reports of your Secretary and Treasurer.

With a wish for your kind consideration for myself, as I shall attempt to preside over your deliberations, I now invite you to the business of the convention.

J. H. SETCHEL,
President.

An adjournment of five minutes was then taken for new members to sign the constitution. On reassembling, Secretary Sinclair read his report, as follows :

SECRETARY'S REPORT.

When the last annual convention met this association consisted of 297 ordinary members, 13 associate members, and 12 honorary members. The number of members on the roll at the present time is 332, being made up of 307 ordinary, 12 associate and 13 honorary members. During the year 27 new ordinary members and one associate member were added to the roll, and one ordinary member was elected to the list of honorary members. Among the changes in the roll, 2 ordinary members and 1 associate member resigned, 13 ordinary members and 1 associate member have been dropped for non-payment of dues, and 2 ordinary members, Mr. S.W. Haines and Mr. George C.Watrous have died.

The annual report containing the proceedings of last convention was delivered to members in the middle of August, and is a volume of about the usual size. Sixteen hundred copies of that report were printed, 1,216 copies have been disposed of in the usual way, leaving a good supply for future needs. A resolution was adopted at last convention recommending the reprinting of back numbers of the annual reports which were out of print. In compliance with that resolution 700 copies of the Fourth Annual report have been printed. There appears to be a growing demand

among scientific societies for full sets of annual reports of this Association.

During the course of the year numerous circulars and communications have to be sent to the members of this Association, and it is very desirable that your Secretary shall have the correct address of every name on the roll. The exigencies of railroad service make changes of location numerous, but it is very rarely that a member thinks it necessary to send notice of change of address. Your Secretary would request that members give their co-operation in maintaining a correct address list.

The following contributions have been received for the Printing Fund during the past year:

Allegheny Valley	$10 00
Atchison, Topeka & Santa Fe	10 00
Ashland Coal and Iron Co	10 00
Baldwin Locomotive Works	25 00
Baltimore & Ohio	10 00
Boston & Albany	10 00
Brooks Locomotive Works	25 00
Buffalo, Rochester & Pittsburgh	10 00
Canadian Locomotive Works	10 00
Central Railroad of Georgia	10 00
Central Iowa	10 00
Charleston & Savannah	10 00
Chesapeake & Ohio	10 00
Chicago & Eastern Ill	10 00
Chicago, Milwaukee & St. Paul	10 00
Chicago, Rock Island & Pacific	10 00
Chicago, Santa Fe & California	10 00
Chicago, St. Paul & Kansas City	10 00
Chicago, St. Paul, Minneapolis & Omaha	10 00
Cincinnati, New Orleans & Texas Pacific	10 00
Cleveland, Akron & Columbus	10 00
Cleveland, Columbus, Cincinnati & Indianapolis	10 00
Connecticut River	10 00
Colorado Midland	10 00
Delaware & Hudson Canal	10 00
Delaware, Lackawanna & Western	10 00

Denver & Rio Grande	10 00
Duluth, South Shore & Atlantic	10 00
Fitchburgh	10 00
Grand Rapids & Indiana	10 00
Grand Trunk	10 00
Houston & Texas Central $10.00 (received too late to go into this year's account).	
Intercolonial (two years)	47 00
Kansas City, Ft. Scott & Gulf	10 00
Lake Erie & Western	10 00
Lake Shore & Michigan Southern	10 00
Lehigh Valley	10 00
Louisville & Nashville	10 00
Louisville, New Albany & Chicago	10 00
Louisville, New Orleans & Texas	10 00
Michigan Central	10 00
Missouri Pacific	10 00
Nathan Manufacturing Co	25 00
New York Locomotive Works	10 00
New York, Lake Erie & Western	20 00
New York, Chicago & St. Louis	10 00
New York, Ontario & Western	10 00
Norfolk & Western	10 00
Northern Pacific	10 00
Ohio & Mississippi	10 00
Old Colony	10 00
Otis Iron & Steel Co	25 00
Pedrick & Ayer	10 00
Philadelphia & Reading	10 00
Philadelphia, Wilmington & Baltimore	10 00
Porter Locomotive Works	10 00
Portland Locomotive Works	10 00
Pittsburgh Locomotive Works	10 00
Prosser & Son	25 00
Raleigh & Gaston	10 00
Rhode Island Locomotive Works	10 00
Richmond & Allegheny	10 00
Richmond & Danville	10 00

Rogers Locomotive Works	50 00
Schenectady Locomotive Works	10 00
Shoenberger & Co	10 00
Solid Steel Co	10 00
Southern Pacific	10 00
St. Louis & San Francisco	10 00
St. Paul & Duluth	10 00
Terra Haute & Indiana	10 00
Toledo & Ohio Central	10 00
Union Pacific	10 00
Vermont Central	10 00
Western Maryland	10 00
Western New York & Pennsylvania	10 00
Wilmington & Weldon (two years)	20 00
Wisconsin Central	10 00
Total receipts from Printing Fund	$ 942 00
Receipts from dues and initiations	1,493 00
Receipts from sale of reports	40 00
	$2,475 00

ANGUS SINCLAIR,
Secretary.

On motion the Secretary's report was accepted.

TREASURER'S REPORT.

Secretary Sinclair read the treasurer's report, as follows:

June 18, 1889.

Cash on hand as per last report	$ 735 25	
June 21–88—Rec'd A. Sinclair, Sec	651 00	
June 17–89— " " "	1,824 00	
		$3,210 25
June 21–88—Paid A. Sinclair, Sec. salary	$1,200 00	
June 21–88—For Rink at Alex. Bay	25 00	
July 28–88—Reporting	131 37	
J. M. Allen	6 00	
McGowan & Slipper, printing	49 45	
Donnelley & Sons, printing	170 30	
Donnelley & Sons, printing	431 36	
George H. Benedict, engraving	109 95	
Transportation	1 87	
Charles Starr, printing	2 25	
Insurance	8 00	
Expense of Secretary's Office	106 68	2,302 23
Balance on hand		$ 908 02

GEO. RICHARDS, *Treasurer.*

On motion the Treasurer's report was accepted.

The President announced that the regular assessment would be $5.00, and that Messrs. G. Richards and H. Tandy would receive the dues. A recess of five minutes was then taken for the payment of dues.

APPOINTMENT OF NOMINATING COMMITTEE.

THE PRESIDENT.—The next business in order is the appointment of a nominating committee. I will appoint as such committee William Swanston, R. W. Bushnell, Allen Cooke, James M. Boon and John Hickey. It will be the duty of this committee to furnish the Secretary with a list of nominees for the officers of the convention as early as possible, or, at least, before the election.

ELECTION OF AUDITING COMMITTEE.

The next business in order is the electing of an auditing committee. Nominations may be made by any member and the committee is to be elected by ballot. Nominations are in order.

SECRETARY SINCLAIR.—I move that J. Davis Barnett be a member of the committee. Seconded.

MR. H. N. SPRAGUE, Porter Loco. Works—I nominate J. N. Lauder for another member of the committee. Seconded.

MR. JOHN MACKENZIE, New York, Chicago & St. Louis—I nominate W. H. Lewis. Seconded.

THE PRESIDENT—Gentlemen, please prepare your ballots.

MR. MACKENZIE—Would it be in order to elect them by acclamation?

THE PRESIDENT—The Constitution specifies that they are to be elected the same as officers—by ballot.

MR. MACKENZIE—I move that the secretary be authorized to cast the ballot for the nominees.

MR. R. H. BRIGGS, Kansas City, Memphis & Birmingham—I second the motion.

The motion was carried and the Secretary cast a ballot for the persons nominated.

THE PRESIDENT—Gentlemen, Mr. J. Davis Barnett, Mr. J. N. Lauder and Mr. W. H. Lewis are an auditing committee for the purpose of examining the accounts of the Secretary and Treasurer.

The next business is unfinished business. Is there anything remaining over from last year?

SECRETARY SINCLAIR—Mr. President, the only business remaining over from last year is the notice of the amendment to the Constitution, but I understand it is not going to be brought up; so there is nothing left.

Secretary Sinclair read a letter from the Leslie Rotary Steam Snow Shovel Company, inviting the members and their friends to a steamboat ride on Lake Ontario, at any time the members might agree upon. The invitation was accepted for Wednesday afternoon, after the close of the meeting.

INITIATION FEE.

THE PRESIDENT—I think, gentlemen, that the matter mentioned by the President in his address as to fixing an initiation fee, which was omitted entirely in the new constitution, should receive attention. There certainly should be an initiation fee.

MR. SPRAGUE—Is it in order to make a motion for that?

THE PRESIDENT—It is necessary to give notice of a motion to amend at the next annual meeting.

MR. SPRAGUE—I move that the constitution be amended at the next annual meeting fixing the initiation fee at one dollar.

MR. J. N. LAUDER, Old Colony—It does not seem to me that it is necessary to put into the constitution of this association the amount that may be fixed as the initiation fee to be paid by new members. It seems to me that it might just as well be stated in the constitution that we should pay $5 annual fee, or that we should pay $10, or that we should pay $15. Now the initiation fee is merely nominal. We can fix it at nothing or at one dollar, or any number of dollars we see fit, and I would move that the initiation fee be fixed at $1.00 until further ordered by the association.

MR. P. H. PECK, C. & W. I. & Belt—I second Mr. Lauder's motion.

MR. MACKENZIE—I think, Mr. President, that it is not necessary to have any initiation fee. If we were to have an initiation fee, I should say make it $25, rather than one dollar. It does not seem necessary for a man to come in here and put down his name and give us a dollar, and then for us to ask him for $5.00 more for dues for the coming year. It looks to me that if a man is recommended, as we are proposing shall be done under the new constitution, the names of those who recommend him should be enough. I do not see the object of the initiation fee. It is so small that it amounts to nothing, and for that reason I should vote against it. I do not think it is necessary.

SECRETARY SINCLAIR—I should like to support the position of Mr. Mackenzie on that subject. An initiation fee of one dollar amounts to very little in the course of a year. It has a tendency to complicate the accounts, and I have found an incoming member often thought that it was a very small proceeding to take a dollar from him. They seem to think that it would be much better to take $5. If you are disposed to fix it so small as that, I think it will be better for the association to leave it alone altogether.

On being put to the meeting, the motion to fix the initiation fee at one dollar was lost.

DISCUSSION OF TOPICAL SUBJECTS.

THE PRESIDENT—It is twelve o'clock, and according to our constitution, the hour between 12 and 1 o'clock is devoted to the discussion of such questions as may be handed in by the members. If the members have any subject now that they wish to bring up for discussion, they can hand it to the Secretary.

SECRETARY SINCLAIR—Mr. O. Stewart, of the Fitchburg road, proposes the following:

"THE CAUSE OF BURST STEAM CHESTS."

MR. STEWART—Mr. President and Gentlemen: At first thought the cause of the bursting of steam chests seems to be a very simple matter. They all say, "it is because they are weak, of faulty construction, perhaps. We have very tight throttles closed and fastened, while the reversing of the engine brings pressure to bear upon the chest, which it is not able to sustain. That is the cause of the bursting and breaking of steam chests."

This is a matter that has been brought largely to my attention within the past two or three years, from the fact that we have had a great many burst steam chests. It has led me to look more deeply into the subject than merely saying the chest was not strong enough. I concluded that there must be a cause back of that which led to the bursting of the chest. In almost all instances I have found that where a chest has burst it has been on a down grade, or an up grade where some obstruction has presented itself to the engineer and he has been obliged to reverse his engine. Now, under ordinary circumstances, reversing an engine does not hurt the chest. Almost all engines will stand that, but the subject came to me, as I say, because it was done in those places. En-

gines were reversed in other places. There was no material injury done—no chests broken. I was led to inquire into this matter and I found that invariably it was after the valves had been oiled copiously in the old style through cups in the cab. Now I do not pretend to know what is the cause of the bursting of the chest. I come here for information. I presume most of you gentlemen have had the same experience, but my idea is this, that after oiling the valves, the rapid motion of the piston in the cylinder increases the natural heat of the cylinder; that there is formed by this friction a heat and gas in the cylinder in connection with the oil that has been put in, and that in the reversing of the engine, cold air being drawn in, strikes this gas and an explosion is caused. I do not believe that it is ordinary pressure. I believe that there is something there besides pressure resulting from reversing the engine. I say this is the fact—that these chests have been burst directly after oiling the valves. Now then, if steam is used for a short distance after oiling the valves, then the engine may be reversed and no exploslon occur and no chests are broken. I would like to hear from other gentlemen on this subject.

MR. J. N. LAUDER—This is a question to which I have given very little thought, but I think it is a good deal like the old one as to what produces boiler explosions. I believe that the engine that is continually bursting her steam chest is of faulty design or faulty material. I never had a steam chest burst unless it was through a corner or some other weak spot in the chest. We bore a hole through the front of the chest and screw in an air valve, oftentimes without reinforcing it, and it breaks there. As a rule it is very weak. Oftentimes it will crack off when the engine is running and doing regular work—pulling a train — not being reversed at all. I think it is all because the steam chest is too weak. I do not believe there is anything mysterious in a boiler explosion; I do not believe there is anything mysterious in a burst steam chest. I believe that it is simply the inability of the metal to stand the extreme strains that it is put under. There may be some hidden cause, as Mr. Stewart suggests. There may be an explosion of the gas that is generated by high heat, due to extreme pressure; but I should hardly think there was anything of that sort that caused burst steam chests. It is due to poor material, perhaps, in chests, poor iron and the weak design. That is my notion about it.

MR. JOHN MACKENZIE, New York, Chicago & St. Louis—That is a question which troubled me a great many years ago when I used to have to earn my living by running an engine, and I recollect once or twice when the red light got too close to me, that I reversed the engine very suddenly and opened the throttle and saw the steam pressure going from 140 — well, going around a second or third time; I couldn't tell how many times. I do not think it was steam that did that. There was a pressure there, because the gauge indicated it very plainly—so much so that I was almost afraid to stay on. As Mr. Stewart says, it must be a gas that is formed by the action of the piston, because if an engine is reversed at a slow speed this pressure will not occur, but at a rapid speed of the piston, if the engine is reversed, the indications will be of an excessive pressure in the boiler. Now, the gas, which I think it is, is simply

air sucked down through the stack into the exhaust ports and into the cylinder and up into the boiler. That has been my experience. Like Mr. Lauder, I have had a great many steam chests blown off, but we found always, as he says, a defective casting. You will find it in slow speed as well as high speed. Wherever we found a steam chest burst, we put our finger on the weak spot and strengthened it up a little.

MR. LAUDER—There is one thing that, perhaps, has an important bearing on this matter. The throttle valve that is now used, I might say universally, is the double-poppet, so called balance valve—it is balanced. Now, pressure under that valve will not open it. With the old fashioned slide valve, whether you open the throttle valve or not, as soon as a pressure is pumped up into that valve greater than is in the boiler to hold it down, it would lift and relieve itself. Now, we have a valve which pressure will not open from the cylinder side. If the engineer reverses his engine he has got two immense air pumps which do not take long to accumulate an enormous pressure, and unless he opens his throttle a little bit to allow that pressure to pass into the boiler he has got a very small reservoir for the accumulation of pressure. There is no doubt in my mind but that the bursting of a steam chest, when the engine is suddenly reversed at high speed, is simply the letting go of the weakest part. I believe if the steam chest was strengthened up, possibly something else under the same circumstances, might go. I have a case in mind, of which I presume some of you have heard, that occurred on the limited New York train of the Boston & Albany road. The engine was reversed in order to avoid running into a freight train, and it knocked out both cylinder heads. That has a direct bearing on this. The cylinder head was probably weaker than the steam chest. What did it? It seems to me it was simply an accumulation of pressure due to the action of the pistons in the cylinders, which, while running reversed, are simply two large air pumps, very effective air pumps, too. Now, if the engineer in that case had opened his throttle the accident would not have happened. That is, he might have struck the freight train, but he would not have knocked his cylinders out. In that case, I think the accident was due to the incompetency of the engineer.

MR. STEWART—I know, gentlemen, that that is the theory that has been commonly accepted. I am not satisfied with it, however. We all know that an engine may be reversed when she is running and her wheels turned the other way without breaking her steam chest or without knocking out her cylinder head. It does not take any more power to do it at one time than it does at another—not actual power. Now then, why is it? This is the point I make here: Is it that after oiling the valves and before the throttle has been opened that steam chests are burst?

MR. MACKENZIE—Do I understand that the steam chest is burst when the engine is in forward motion, for instance, and the throttle shut off?

MR. STEWART—No sir; running ahead and in back motion—reversed. Now, in a case which occurred perhaps a year ago on our road, running down a very long grade about sixty feet per mile, a passenger train came into Fitch-

burg, the air brakes failed to hold, and as usual the engineer called for brakes and the brakemen were not there. If they were they would not know how to use the brakes at the present time. The engine was reversed. It did not make a dozen revolutions before both chests went into the air in a dozen pieces. Now, then, there is a cause for it, and that is what I am asking for, if any other gentleman has had the same experience, if he has gone to the bottom of this and found out what the cause is.

MR. LEWIS F. LYNE—I do not believe in mystifying this matter of the explosion of steam chests or cylinders. I think that the explosion of steam chests or cylinders is altogether different from boiler explosions. Now, it is well known in chemistry that a proper mixture of oxygen and hydrogen gases will go off spontaneously. As an example of that we have the recent explosions in the electrical subways in New York city, where the atmosphere combined with sewer gas and the leaking of the illuminating gas caused spontaneous combustions or explosions. It is absurd to suppose that those gases were ignited by a spark from the electric current, because it is well known that there was no leakage of the electric current in those subways. I have seen explosions of steam chests, and upon examination it appeared to me that they were more of the character of an explosion than the giving out of weak parts from over-pressure. In reversing a locomotive you draw in the atmospheric air from the exhaust nozzles; you have a quantity of hydrogen in there already from the leakage of the steam from the throttle, and it is perfectly natural to suppose that those means would bring about the requisites of an explosion of gas—a spontaneous explosion within the steam chest and cylinder heads. I have known both cylinder heads to be blown off in a case of that kind. Now, recently in a locomotive works, I was examining these air valves and I found that they had put on a pressure valve, or a pop valve, in combination with the air valve, to relieve excessive pressure in the steam chest. I will give you another example of this spontaneous combustion or explosion. A leak occurred in the tube of a marine boiler. The steam blew back into the furnace. The hydrogen in the water combined with the atmospheric air in the furnace and blew the furnace doors open and set the vessel on fire. I am acquainted not only with this instance but with several others of the same character, but I will not take up your time with those examples. Suffice it to say that those explosions may be brought about by natural laws, and there is not anything mysterious about them at all, as every chemist knows.

MR. JAMES M. BOON, West Shore—I think the steam chest bursts because it is not strong enough. In the first place, in the general run of steam chests, the design is bad. A square box is used—the very worst shape to resist internal pressure—the thickness running from seven-eighths to one eighth of an inch. They are under constant strain until the time they give way. The increased pressure due to reversing, etc., I think, has little weight to it, from the fact that whatever pressure may be in the steam chest is constant, if you increase that pressure over what the safety valve is set to, the increased pressure will escape to the safety valve. That pressure that comes back from

pumping the cylinder must, in every case, be greater than the boiler pressure to burst the cylinder.

SECRETARY SINCLAIR—I think that steam chests break from natural causes when an explosion occurs, and therefore I wish to take up Mr. Lyne's remarks. I do not think that those instances that he cites would be regarded as natural causes, or in the ordinary run of natural causes. That explosion of a combination of oxygen and hydrogen is a very questionable matter. Most people who have studied chemistry understand that an explosion takes place only when those gases are given a spark of heat; that you can mix hydrogen and oxygen in the exploding quantities with perfect safety so long as you do not raise them to the igniting temperature, and it is at the igniting temperature that the explosion takes place. There is nothing in the steam chest of the locomotive, or in the cylinder of the locomotive, that is calculated to separate the hydrogen from the steam, and therefore put it in a position for exploding by a mixture of atmospheric air. When the engine is reversed you are not using steam. The gas that you are compressing is atmospheric air, and as far as I have seen, in the practical working of locomotives, it is the excessive pressure from a strong air pump, which the cylinder becomes, that causes the pressure that leads to an exploslon, just as Mr. Mackenzie has said. However, my experience has not agreed with Mr. Lauder's, that the ordinary balanced valve or double poppet valve used for throttles does not permit the air to pass into the boiler. While indicating locomotives, I have taken every opportunity I could get to have the engineer reverse the engine in order to see what diagrams I would obtain reversing, and I never could get a very high steam chest pressure. I could get a little higher than boiler pressure—just the kind of pressure that one would expect from a powerful air pump that was not relieving itself very quickly—but there was no pressure that would approach the exploding pressure of the strength that good steam chests have. I have known, however, of one or two cases, though they were not just exactly authenticated, where explosions were said to have followed the putting of kerosene in the cylinders to clean the pistons and then suddenly reversing the engine. That would support, to some extent, Mr. Stewart's theory. Of course, we all understand that an oil of that sort gives off a volatile gas that is very explosive, and the pressure put into the cylinder might be such that it would raise it to the igniting temperature of the gas; that is, the mechanical effort would be transformed into heat and therefore raised to a point where the firing of the explosive mass would take place.

MR. GEORGE GIBBS, Chicago, Milwaukee & St. Paul—My belief is that both the speakers are comparatively right in their theories about explosive gases It certainly is known to chemistry that there are many combinations of gases, which will explode spontaneously; though, unless my recollection is wrong, they are not hydrogen compounds so much as nitrogen compounds. Now when the cylinder, under the circumstances Mr. Stewart mentioned, is oiled copiously, the usual lubricating oil contains a certain quantity of light hydro carbon material which is easily vaporized, particularly if the chest is at

all dry. I do not believe there is any spontaneous ignition there, however. Our knowledge of compounds which will explode spontaneously is a little indefinite. I think it can be explained by the supposition that the igniting temperature is present there. As far as getting the pressure there is concerned, we have had no trouble with that from two reasons; one is that we use a pop valve on the chest, and the other is that our throttle valve has a certain amount of play in the stem, and it rises when the pressure in the steam pipe is developed above the boiler pressure.

MR. LYNE—I shall still have to adhere to the view I expressed at first in reference to the natural causes which produce those explosions. In the first place Mr. Sinclair says that from the indicator diagrams that he took, the pressure did not rise much above the boiler pressure, and we all know that these steam chests are proportioned very much in excess of any pressure which they will be required to stand under ordinary circumstances. So the pressure alone, it seems from the indicator diagrams, would hardly be expected to burst those parts. I know that in the case I cited of those explosions in the electrical subway there was no fire to ignite the gases. That has been proved and pretty definitely settled. Now in philosophy we have what is known as the compression syringe. It is a glass tube with a plunger, and by suddenly forcing down that plunger, you can raise the temperature so as to ignite a piece of tinder in the tube. Now may it not be possible by suddenly compressing the air as we do in the cylinder—for the two cylinders certainly act as powerful air compressors as soon as the engine is reversed—may it not raise the temperature sufficiently high to ignite the gases? The gases may not be formed wholly of oxygen and nitrogen. We have the volatile gases of the lubricating oil, and that alone in itself is a very explosive mixture. May not those gases be ignited, as I say, by the sudden compression of the atmosphere? I think that natural causes produce those explosions. I do not see anything mysterious about it at all.

MR. P. H. PECK, C. & W. I. & Belt—In my experience in reversing engines I find that cinders get in there. Probably there might be a red hot spark get in there. Your cylinder cocks will all stop up in those cases. I have seen nearly as many steam chests burst on grades as on reversing. For that reason I have given no attention to spontaneous combustion.

MR. JOHN WILSON, Union Pacific—I do not see where this pressure cuts any figure. The bursting of the steam chest is due to the fact that it is too weak. I do not think there is any part of an engine that has been oftener constructed too weak, and on what we might call a wrong design, than the steam chest of a locomotive. You take cast iron and it is one of those materials with which you can do almost anything, if you understand its nature. But look at the form of an ordinary steam chest—especially the old fashion steam chest. Now, as Mr. Lauder has stated, it is a very common occurrence for a steam chest to give out; but with a new design properly constructed and properly designed, he never heard anything more of it. Now, I do not see that it makes any difference whether it is an explosion or whether it is an over-

pressure, and I do not blame lots of chests, I have seen, from bursting. I would do it myself, if I were made the way they were. [Laughter.]

MR. STEWART—I am not prepared to accept the theory of the last speaker. There is something in that chest after you have oiled the valves of the engine —there is something there that was not there before you oiled your valves. Now, then, we take an engine that runs right along, day after day; we have no trouble with it at all; the chest is all right, the joints are all tight and strong enough to stand 160 pounds pressure. You are running down a grade; you oil your valves—and most firemen put in three or four times as much oil as is necessary into their valves where they oil from the cab. Now, if you will use a little steam before you reverse your engine you never burst a chest, but on the contrary, if after oiling your valve you reverse your engine before using steam, my word for it, in four times out of five you will burst a chest. What I am here for is to find out what the occasion of that is. I confess I do not know what it is. I presume other gentlemen have had the same experience I have had. The chests are bursting, and I am not inclined to sit down and say that because a steam chest has burst it is weak. If I can reverse an engine and open the throttle instantly, and that engine will turn back and her wheels will slide for half a mile or a quarter of a mile, and then if, again, by reversing that engine she makes a dozen revolutions and she bursts the chest, I want to know the reason why. I am asking for information.

MR. MACKENZIE—What I want to ask Mr. Stewart is this: whether or not he used the cylinder lubricator, admitting the oil into the cylinder with the steam, or if he was using the old-style cups, admitting the oil only at certain intervals into the cylinder. Now, it seems to me that the idea which he presents here, that if you open your throttle a little way before you reverse your engine an explosion will not occur, is not well taken, for this reason: that we use a cylinder lubricator; the oil is admitted to the cylinders in the steam, and the oil and steam are admitted regularly all the time—so many drops a minute. Now, we know that by reversing an engine under those conditions, the steam chest will be blown off; not only will it burst the steam chest, but it will blow the studs and everything connected with it off. We have had such cases. Now, as to the heat generated in the cylinder, there is no question in my mind but that there is heat there, and it is not only the heat of the atmospheric pressure, or whatever it may be coming into the exhaust, but the heat of the friction of the piston. I heard a gentleman say here a few moments ago that he had found sparks in his cylinder-cocks when he reversed his engine. Now, I have seen smoke come right out of the cylinder-cocks through from the boiler and through the cylinder-cocks. Now, it strikes me there must be some heat with that smoke—heat enough to ignite anything—1,200 or 1,400 degrees.

MR. STEWART—In reply to the gentleman, I would say that where we use the sight-feed lubricator we have not had an explosion. It is only where the cylinders are oiled through an oil-cup in the cab at stated intervals by the fireman that we have explosions.

On motion of Mr. Mackenzie the discussion was closed.

DIMENSIONS OF AXLES FOR TENDERS OF HEAVY CAPACITY.

SECRETARY SINCLAIR—This subject is proposed: "Dimensions of Axles for Tenders of Heavy Capacity." Mr. W. H. Lewis will introduce it.

MR. W. H. LEWIS, Chicago, Burlington & Northern—I have not given the subject any thought so far as its application to tenders of heavy capacity is concerned; but I have, in connection with establishing an axle of sufficient dimensions to withstand, I think, as heavy strains as we would require of it, and still have it conform to our present standard of the M. C. B. truck and M. C. B. oil box. As you know the question is being agitated about an increase of the M. C. B. standard, and my view of this subject is, that it is desirable to establish a standard as large as possible, and still conform to our present standard of truck and box. It would be a measure of great economy, if we could adopt a standard of that dimension without any other changes except the bearing and wedge. And, as I say in that connection, we have given it some thought; and what I have thought the most desirable, would be an axle 6 feet 3½ inches spread between the centres of journals, the journals to be 4 by 8 inches; the dust guard to be 2¼ inches in length; the distance between the back of the M. C. B. box and the wheel to be ⅞ of an inch; the length of the axle over all would be 7 feet and ¾ of an inch. Now you can use these dimensions in our present M. C. B. truck and box without any change, as I say, except the wedge and bearing. I have some blue prints of such an axle and its arrangements, which are at the hotel. I did not expect, as I say, to speak on the subject, and therefore did not bring them with me. I simply mention it as introductory to the subject, and would like to hear from some of the other members.

MR. J. N. LAUDER—In the matter of axles for tenders, we are building tanks now with 3,600 gallons capacity. That means a very heavy frame, heavy trucks and heavy tank, and a good deal of weight of water. The water alone weighs some 14 tons. Now, I did not dare to trust those tanks of the M. C. B. journal, and I put in a journal 4¾ by 8. I have yet to see anything wrong with that journal. It is what is generally known as Johann's axle. It is collarless, and has a stop wedge at the end. The stop wedge, of course, is a mechanical device for preventing the end-thrust, and anybody can arrange that to suit himself so far as tenders are concerned, because there is no interchange. If anything of that sort was adopted by the Master Car Builders, it would necessarily be included in the journal. The box would have to go with it, so as to have something that would interchange with other roads. I have only one objection to that journal, and that is that stop wedge at the end. When the lateral thrust comes in on rounding curves, and going over inequalities in the track, it brings the strain all on one box. If you have the box in a jaw, like a passenger car truck, the thrust tends to throw that box out. There will be an overweight on that truck, that tends to throw the jaws out, and having a stop wedge simply aggravates the difficulty. With the ordinary diamond truck under freight cars, and those that are largely used under tenders, the thrust all

comes on one side of the truck frame. There ought to be some appliance by which that end thrust could be taken by the box at each end of the journal. It does it with the box on the M. C. B. standard. There you get the thrust on both journals. With the stop wedge you only get it on one. There is a box, however, that has no collar, that obviates this difficulty. It is the Bemis box. I presume some of you are familiar with it. I am using that quite largely under passenger cars, where our road is sandy, with a great deal of success. Really all it amounts to is a good, efficient dust-guard. With that dust-guard must be some appliance to take up pretty thoroughly the end-thrust, or the box will come away from the appliance that keeps the dust out. Therefore, they have turned a groove in the end of the axle and put in a key that fits down into this groove, and that key also slides down in proper receptacles on each side of the box, so that when the end-thrust comes you get the strain on both sides of your truck frame. That, I think, is the best thing I have ever seen for excluding the dust, and also for other purposes, and gives you a chance for getting in as large a journal as you want—even up to 4¾. I think when we are changing from the Master Car Builders' standard to the new, we must be very sure that we get larger, so that in a few years more we shall not have to change again. There is no objection in the world to having a six inch journal, but it is not needed. But my notion is that a 4¾ inch journal is needed, and I hope the Master Car Builders in their wisdom will see fit to adopt something considerably larger than four inches, because I do not think the four inch journal will meet the wants of these heavy loads, that we are now carrying on our tenders and on our passenger and freight cars.

MR. JAMES MEEHAN, Cincinnati, New Orleans & Texas Pacific—I had a little experience with the collarless journal. We first tried the Raoul box. Cars equipped with the Raoul box came in on our road of two or three sizes. I found we had very little trouble from their heating, but I found afterwards that the fastening was very defective. I took up the Johann box and found that was no better, but Mr. Thomas, of the East Tennessee, Virginia & Georgia, is using a collarless journal in a number of very high capacity cars, and I think if you could get him to give you a little history of them it would be very gratifying.

MR. MACKENZIE—Mr. Gibbs has a paper here on the Strength of the Axle, which I would like to have him read.

THE PRESIDENT—Will Mr. Gibbs read his paper?

MR. GEORGE GIBBS--I do not know that I have any paper to read right here. I have some matter to bring forward at the Master Car Builders' on this subject, but I feel hardly prepared to do it now. It seems to me a pity, in view of the fact that the Master Car Builders are going to discuss the question, that it could not be among the subjects for us to discuss—if a larger axle for tenders would not be desirable. We thought of using a larger axle on our 3,600 gallon tanks, but we have not done so yet. We believe in the larger margin of safety that would be allowed by a larger axle. I am glad to hear what Mr. Lauder says, that he would be in favor of larger journals for axles.

I anticipate that we will have a lively discussion on that point at the other convention. The committee will probably report a 4x8 journal. We ourselves are in favor of a larger diameter, keeping the length the same.

Unless other members have thought over the subject of the length of the journal and the length between the centers, I do not think we will accomplish much. Those are the points that will give us more trouble at the other convention. If they succeed in adopting the heavier axle, it seems to me we should work it in for tenders.

SECRETARY SINCLAIR—I would suggest that it is perfectly in order for the Association to discuss that subject which Mr. Gibbs mentioned, and he can easily have it done by bringing it up as a subject for discussion at 12 o'clock to-morrow. In the meantime, as the Association does not seem to be quite prepared to discuss this subject, as members have regarded it as something unusual, I move that the di-cussion be postponed until noon to-morrow, and that Mr. Lewis be requested to bring his drawings and put them up, so that the members shall have the opportunity to examine them and know what he proposes doing. The motion was carried.

PURIFICATION OR SOFTENING OF FEED WATER.

THE PRESIDENT—The next business in order will be the reading of the report on the "Purification or Softening of Feed Water."

SECRETARY SINCLAIR—Mr. President, I have to mention that there is no report produced, and also that this is the second year that the committee has existed. I have received notice from Mr. John Player, the second member of the committee, that he understood that Mr. Herbert Hackney, who was the chairman, had gone to Europe, and he had left no notice with him about the subject; consequently there was no report.

MR. L. C. NOBLE, Houston & Texas Central—I move that this Committee be discharged. I understand that it is two years since they were appointed, and that they have made no report. Motion seconded.

MR. GIBBS—I think some report should be made by this Committee; the Western roads are having much trouble over this question of feed water.

THE PRESIDENT—This does not prevent the subject from being considered, This motion is simply to discharge the Committee.

The motion to discharge the Committee was carried.

SECRETARY SINCLAIR—I have a communication from a member of the Association on this subject. It came in rather late, and I intended to hand it to the Chairman of the Committee as soon as I could find him, but I did not find him, and consequently I still have it in my hands. It is from William Wilson, Superintendent of Machinery of the Chicago & Alton.

MR. MACKENZIE—I move that the paper read be referred to the Committee on the Purification of Feed Water to be hereafter appointed.

The motion was carried.

THE PRESIDENT—The next subject is the subject of Tires; "Advantage

or Otherwise of using Thick Tires." The report is in the hands of the Secretary and will be read.

The report was read by the Secretary and is as follows:

TIRES; THE ADVANTAGE OR OTHERWISE OF USING THICK TIRES.

The Committee appointed at the Alexandria Bay Convention in 1888, to investigate the subject of "Tires; Advantage, or Otherwise of Using Thick Tires," beg leave to submit the following:

Circulars were issued to members, containing a series of questions, to wit:

First.

Please furnish a tabulated statement showing mileage made by a series of heavy and light tires of the same make, upon a form similar to the one inclosed.

The statement given herewith shows the average mileage made per sixteenth inch wear of tires of the same brand and thickness under engines of the same type, weight, size of drivers, etc. It was hoped that the members would liberally comply with this request by showing the performance of a large number of engines of the same class, which would tend to make better averages of varying materials of the same brand, as well as the average handling by a large number of different men.

Of the nine statements at hand, only the Chicago, Burlington & Quincy, and the Chicago, Rock Island & Pacific roads show comparisons between tires of 3 and 4 inches in thickness.

Both of these result, however, in favor of the 3-inch tire, showing for them average increased mileage per unit wear of about 20 per cent. In general the reports received are rather conflicting, and it can scarcely be said that there is any difference in the wearing qualities of the material in the outer rim, inner rim, or inside center core of the same tire. In comparing the mileage of tires varying from 2¼ to 3½ inches original thickness, the thinner ones have averaged a trifle better, although in many cases the thicker ones gave very good results.

Second.

Can you give any figures showing the amount of wear to tires occasioned in handling engines by different engineers?

This question was intended to bring out, if possible, something more definite in regard to the influence the engineer exerts on the wear of tires.

At the last convention it seemed to have been almost a unanimous feeling that the engineer was greatly responsible for the condition of his tires, and of those who expressed their ideas in figures, the lifetime of a tire might be increased from 25 to 100 per cent. by careful handling. The only figures given in answer to this question are by the Illinois Central Railroad. The comparison made gives the mileage of three engines in suburban service. These engines are of the "Forney" pattern, built at the same time and to the same drawings. They are equipped with driver-brakes with the plain shoes, and have the same brand of tires 3½ inches thick. The service is such that each engineer makes the same number of trips over the same part of the road each day with the same number of cars, stopping on an average of every two minutes. Every precaution was taken throughout to make all the circumstances and conditions connected with the running of these engines alike.

The engineers, all of whom are experienced and reliable men were notified that a comparative record of their tires would be kept, and each man was to do his utmost to make a good mileage. The following is the result to date: The first engine made 103,618 miles to $\frac{14}{16}$ inch wear of tire, an average per unit wear of 7,400 miles. The second made 111,345 miles to $\frac{24}{16}$ inches wear, an average per unit wear of 4,635 miles. The third made 112,455 miles to $\frac{26.5}{16}$ wear, an average per one-sixteenth inch wear of 4,234 miles. The average of the remaining 14 engines of the same type and service was less than the third case above mentioned.

Third.

Do not heavy wheel centers with thick tires produce flat spots upon the tread of tires much sooner than light wheel centers with light tires? If so, please send statement showing the difference.

On account of the meager information received to this question, the committee is unable to give any figures on the subject. We recommend, however, that a wheel center of sufficiently heavy

design to safely carry load and resist shocks and strains be used, and that the same be counterbalanced as perfectly as possible.

Fourth.

To what extent does the condition of tires influence the taking of an engine into shop for general repairs?

A large majority of answers to this question were, that the condition of tires directly governed the time between repairs of engines.

Fifth.

In determining the advantage of a thick over a thin tire or vice versa, do you take into account the expense of turning tires?

It has been claimed by many that a thick tire is cheaper or better on account of the lesser percentage of material scrapped after being worn out and the consequent increased percentage used in wear.

All other things being equal, and taking into account the original cost, crediting this with the scrap after tire is worn out, a 4-inch tire will cost 10.9 per cent. less per thousand miles run than a 3-inch tire.

Sixth.

What is the cost at your shop of disconnecting an engine, taking out wheels, turning tires and replacing wheels ready for service?

This amount varies from $14.50 to $37. As a rule the condition of tires causes an engine to be taken into shop when otherwise she would have made in many cases from 20 per cent. to 50 per cent. more mileage before requiring repairs to machinery, but being in for tire turning, and different parts of the machinery taken down it is generally considered advisable to do a limited amount of work to the machinery, so that it will not be necessary to hold the engine for this work before she comes in again for tire turning, and it is safe to say that quite a large proportion of the expense of repairs to machinery is directly caused by tire wear.

Seventh.

In conclusion, state the reason why you think a thick tire better than a thin one, or vice versa.

Though the records of wear of thick and thin tires received could scarcely be taken as a general average, it is all the commit-

tee have to consider. This wear showed about 20 per cent. more mileage in favor of the 3-inch tire, whereas, in comparing the cost, we find the 4-inch tire is 10.9 per cent. cheaper than a 3-inch tire. Now, with all the other influences incidental to tire wear, such as use of sand, slipping drivers, use of driver-brake, the fact that one set of tires will do much better than another set of the same brand and thickness under the same engine handled by the same engineer, the diversity of opinions of the members of this association, the committee find it very difficult to say with any degree of certainty which of the two is the better.

Undoubtedly the best and most economical tire for railroad purposes is the one making the greatest mileage per unit of wear. A greater service from the engine is thus obtained on account of fewer interruptions to business, with a corresponding decrease in repairs to engine, but to determine to a certainty the original thickness or the physical condition of the metal to perform this mileage is a problem requiring much more definite data.

The Illinois Central has prepared a statement showing the performance of 252 sets of tires of the same brand, varying from $2\frac{1}{4}$ to $3\frac{1}{2}$ inches in thickness, and worn out in all kinds of service. The total mileage made by these tires was 45,698,728 miles, and the total wear amounted to $\frac{3988}{16}$ of an inch, or 20 feet, $9\frac{1}{4}$ inches wear of steel, being an average of 11,459 miles per one-sixteenth of an inch wear of tire. Another statement shows the performance of 33 sets of tires of another brand, varying from $2\frac{1}{4}$ to $3\frac{1}{2}$ inches in thickness, and worn out in similar service. The total mileage made by these tires was 5,087,042 miles, and the total wear amounted to $\frac{621.5}{16}$, or 3 feet, $2\frac{27}{32}$ inches wear of steel, being an average of 8,185 miles per one-sixteenth of an inch wear of tire. The cost of the former tires was $7\frac{3}{4}$ cents per pound and of the latter $5\frac{1}{4}$ cents per pound, a difference of 32.2 per cent. in favor of the latter; but the cost of the metal worn off for each one thousand miles made by the former being 12.78 cents, while the cost of the latter was 12.19 cents, leaves the difference in favor of the latter only .59 of one cent for one thousand miles' run.

Now, when we take into consideration that, on account of the poorer mileage, the latter tires required to be turned five times

during the same period that the former only required four turnings, and that comparatively the service of the engines of the latter was lost during the fifth turning, it certainly proves the former to be the cheaper tire of the two, although at a great difference in original cost.

Through the kindness of Mr. J. N. Lauder, we append hereto a paper on "Tire Metal," prepared by Mr. J. E. Howard, Engineer of Tests at Watertown Arsenal, as follows:

SOME NOTES UPON TIRE METAL.

At the twentieth annual convention, Mr. J. N. Lauder presented the results of some tests made at the Watertown Arsenal, upon the tenacity, hardness and density of two sections of 3-inch and 4 inch Midvale steel tires. These results, it will be remembered, showed the two sections to have had nearly the same physical properties.

"At the request of Mr. Lauder, I have the honor to present a few remarks touching upon some of the questions involved in the general discussion of tire metal.

"The durability of a tire obviously depends upon the quality of the metal and upon the conditions of service.

"It is a comparatively simple matter to ascertain what the primitive qualities of a metal are, and the information derived possesses great value, because it would seem if the relations between the physical properties and the effects of certain conditions of service were once definitely established that the physical examination would thereafter serve as a guide to identify what constitutes good tire metal. Before these relations are established, information from independent sources is desirable to obtain and naturally possesses more or less interest.

"In considering the influence of physical properties upon the durability of a tire we have to consider—first, the elastic limit of the metal. If the elastic limit was never exceeded obviously no wear would occur, for the particles of the metal would not be displaced beyond the limits of recovery and immediate restoration would be expected upon the release of load. If, however, the elastic limit is exceeded, either throughout the entire section of metal or locally, a permanent set results; some parts are forcibly moved to new positions, and if the process is repeated,

rupture eventually ensues. In case local disturbance was alone received, only a small portion may rupture, and it is then said that abrasion or wear has taken place.

"The behavior of the metal between the elastic limit and the time of rupture may depend upon attendant circumstances. Under a gradually increasing load large ductility may be developed, and on the other hand repeated loads may cause rupture with almost absolutely no display of ductility. Between these extremes varying degrees of ductility may be developed. If an exceptionally high load could never be received, it would be logical and consistent to prefer a metal of the highest attainable elastic limit, but such a metal under no circumstances would have much ductility. Until further experience has been gained it seems the part of prudence to employ for most purposes a metal which is capable of displaying ductility, although the conditions of service may not render such display at all times possible, and with ductility the metal should of course have a good elastic limit and ultimate strength.

"In a homogeneous metal the tensile strength is substantially the same in any direction it may be tested. The metal may also resist loads acting in different directions at the same time; and further, if a load is applied in one direction we may avail ourselves of the strength of the metal in different directions to assist resisting it. A practical application of this idea is found in the employment of a grooved form of tensile bar and convex surfaces under compression or where the pressure is applied to only a part of the surface. In the grooved form of tensile bar the actual cross-section of metal resists the stress, and the lateral metal supports the net section by reason of lateral cohesion. Under compression, if only a part of the surface received a load, that part is reinforced by the surrounding metal and higher resistance results than due to the resistance of the metal in one direction. In connection with this behavior of the metal comes the query—what would be the ultimate resistance under compression if the lateral support was sufficient to entirely prevent flow? In experiments on cubic compression it has been found that ductile steel is capable of resisting an hydrostatic pressure of 90,000 to 117,000 pounds per square inch without any apparent change in tensile or

compressive qualities. The bearing which these facts have upon the question of maximum allowable wheel or tire pressures will be clearly seen. The shape of the rail-head and tire are both important as regards the amount of surface in contact and the amount of reinforcement given the contact surface by the adjacent metal. From this point of view it may be seen why it is practically a very difficult matter to so proportion the shape of these surfaces that maximum efficiency will result.

"The presence of sand between the tire and rail occasions intense local compression, and may, and no doubt does, cause stresses exceeding the elastic limit of the metal of both the tire and rail. The elastic limit of rail and tire metal commonly exceeds the crushing strength of the rock used for building purposes. Exceptional strength has been met in the case of granular quartz, where a resistance of over 50,000 pounds per square inch has been found. Considering the ultimate crushing strength of the particles of sand and grit and the fact that more or less of their substance remains between the tire and rail, tending to cause unequal distribution of load, it was thought sufficient to explain the manner in which the resistance of the metal may be overcome, and thereby account for the extra wear of the tire and rail under such circumstances.

"Concerning the effect of reversing the stresses in iron and steel, direct experiments have shown that stresses exceeding the elastic limit cause serious disturbance and the indications point to the conclusion that alternate stresses are more detrimental than stresses in one direction only, provided in each case the primitive elastic limit is exceeded.

"Such being the case, we should infer that frequent reversals in the direction of running would be a cause of increased tire wear, and drivers with brakes, in addition to the direct abrasive action, would experience a difference in abrasive action against the rail when the brakes were applied, over the period when they were not applied. When driving, the tendency of the driver is of course, to slip one way, but when the brakes are applied the tendency is virtually to slip in the opposite direction although the driver continues to rotate in the same direction as before, and thus is introduced the effects of alternate stresses, in a measure, yet without

actual reversal of direction. Furthermore, it will be seen that when the brakes are set the tendency of the brakes is to abrade or grind off the metal in one direction while the tendency of the rail at the time is to grind it in the reverse direction, and thus we have practically reversed stresses at each rotation of the driver while the brakes are in action.

" Inasmuch as intense heat is generated between the brake shoe and tire, sufficient to ignite particles of metal, one of two things might happen ; either the rapid chilling of this heated surface by the adjacent metal might harden the surface, or if the abrasive action of the rail came while the metal was at a high temperature, increased abrasion might be expected by reason of the loss in elastic limit which the metal experiences while hot. The point just raised suggests the query whether abrasive action of the brake-shoe is appreciably different according to its position in front or behind the wheel. If in front, very little time elapses during the transit of the metal from under the brake-shoe to the rail, but relatively considerable time intervenes if the brake is behind the wheel.

" Considering the effect of speed, assuming the magnitude of the stresses unchanged, it appears from experimental research that steel may be loaded and unloaded at least at the rate of one-fortieth of a second without the effect, being unlike slow loading provided the loads are kept within the elastic limit. If, however, the loads exceed that limit the metal does not respond in its elasticity as before, a rapid increase of temperature following. With means at hand for dissipating the heat it would then seem that increased speed might tend to diminish abrasion. This result is reached when other features are eliminated, but it would seem under the actual conditions of service of a tire that the intensity of the stresses might be so much increased at high speeds as to entirely overcome the favorable features and result in a decided loss instead of gain. In the track complicated conditions are met, some of which conditions we learn from direct experiments have favorable tendencies and others are unfavorable. If the effect of high speeds could be considered only in relation to the sudden displacement of metal, all other features being eliminated, increased tire resistance against wear might be expected. Although we can

not accept any such premises in the practical consideration of the subject, yet an understanding of the elementary features materially assists in locating the true causes of abrasion and wear.

"The elasticity possessed by the tire, the wheel center, the rail, tie, and finally road-bed, all have an influence upon the tensity of shocks incident to high speed. Under direct loads, the tire and rail metal have about the same rigidity and are more rigid than the other parts mentioned. Tires differing in thickness would of course differ in relative rigidity."

This part of the subject admits of direct track observation.

This report throws considerable light on the subject, bringing forth various conditions under which the metal is strained to produce wear, but it also adds new complications to be solved before a definite decision could be reached.

The committee, however, concludes, taking into consideration all the circumstances and conditions of the report, as well as personal observations not mentioned herein, that they can not see any benefit or advantage to be derived in using thick tires.

We therefore recommend to the members of this Association that tires 3 inches in thickness, of the best quality of material, would be the best and most economical for railroad purposes.

We take this opportunity to thank those members of the Association who have kindly contributed to this report, and make special mention of the kindness of Mr. J. N. Lauder, through whom the paper on tire metal was secured.

HENRY SCHLACKS,
C. E. SMART,
J. W. STOKES, } Committee.

MR. MACKENZIE—I move that the report be received and that a vote of thanks be tendered to the Committee.

The motion was carried.

THE PRESIDENT—The subject of tires is now before you for discussion.

MR. MACKENZIE—It seems to me that the question of tires is one we are not very well able to discuss. The Committee have gone over the work very carefully, and I would move that the discussion close now.

The motion was carried.

EXHAUST PIPES AND NOZZLES.

THE PRESIDENT—The next subject in order is the report of the Committee on "Exhaust Pipes and Nozzles."

SECRETARY SINCLAIR—Mr. President, I have not received that report. I understood that the Committee who have the report in hand were making some original investigations in regard to it, and I am expecting the report to be in before the meeting closes, and I would suggest that the subject be passed for the present.

THE PRESIDENT—You have heard the suggestion of the Secretary. What will you do with regard to the matter? If there is no objection, the report will be passed for the present.

The next subject in order is that of "Driving and Engine Truck Boxes, Best Form and Material, including Journal Bearing and Manner of Fastening same in Box." The report is in the hands of the Secretary and will be read.

The Secretary read the report, which is as follows:

DRIVING AND ENGINE TRUCK BOXES.

Your Committee on "Driving and engine truck boxes, best form and material, including journal bearings and manner of fastening same in box" would report that they found these subjects had been pretty well covered in a report to the association at the Washington meeting. Driving boxes are made of cast iron, cast steel, bronze and brass. When made of strong, close iron of good design, cast iron will give good results. In many cases where cast iron is used, the box is not properly proportioned from a desire to use the same size pedestal and box as used for lighter class of engines, or using a larger driving shaft, the box is reduced and made too light, and breakage is the natural result. The weight of locomotives is steadily increasing, yet it is not unusual to find a driving box on an engine weighing 50 tons but little heavier than one for a twenty-five or twenty-eight ton engine. This is one cause of driving boxes breaking. Another is from the desire to have as wide a fire-box as possible; the frames are thrown out, space reduced between frames and hub of driving wheels, making light flange on driving boxes, broken flange the result. When the fire-box is set on top of frames another trouble develops, that is, the danger from hot boxes caused by the cinders and ashes falling from fire-box into driving boxes and bearings, causing them to heat.

Practice has shown cast steel to be an inferior metal for driving boxes; it being a stronger metal than cast iron, weight can be reduced in castings, which is about the only merit it possesses. The most serious objection to it is, that it wears badly when in contact with cast iron, as it must be with inside hub of driving-wheel, when, not only the box wears rapidly, but also the hub.

Your committee has knowledge of 30 engines with cast steel driving boxes, on which the hub and boxes had worn in two years so much lateral motion that ½-inch liners had to be fastened to the boxes. These liners were made of cast iron and brass; the cast iron was found to wear well and gave the best results. At the same time these boxes and hubs were wearing, 70 engines built upon the same plans with cast iron boxes gave no trouble, and after five years' service had not worn lateral motion enough to need taking up.

Another objection to cast steel is, that the metal expands at a low temperature. A bearing becomes hot from some cause, the heat will expand the box more than the brass, which will (if circular shell pressed into box) become loose and necessitate tightening up. Bronze and brass, being alloys of copper, will be treated as one metal. There are but few driving-boxes made of these metals in this country. In Europe it is the rule to use them —they are the best metal for the purpose. Your committee are of the opinion that the coming driving-boxes will be made of these metals, solid bored out to fit the shaft. The thought of the cost of the bronze or brass over cast iron may at first be startling, but it is likely to prove economical, when it is taken into consideration that the patterns can be made lighter than for cast iron, the slotting out for bearing and fitting of same saved, the planing, boring and fitting will cost no more than cast iron, and the box will wear until worn through at the top, or so light as to be unsafe, the loss from wear of bearing will be no greater, and there will be a saving of tightening up old and fitting new bearings.

When the box is finally worn out, the credit for scrap will make a considerable reduction on cost of new box. The objection might be urged that in case of a hot journal the box might be ruined; extreme cases like this rarely occur.

Where bearings had been cut off roughened, it could be re-bored same as is now done with separate bearings. The form of bearing now generally used is the half round shell, the tendency of these bearings is to become loose, the shape of the bearing and the strain it is subjected to contribute to this end. The weight on the crown of the brass and wear on inside naturally causes the lower ends to close in away from the box and binding on the journal, causing heating and pounding of bearing in box.

The weak point of these half round bearings is the lower edges, which take the pressure in forcing bearing into box; these edges seldom have over three quarters inch bearing, and it is not unusual to see them not more than ⅜ inch.

As the shells are forced into place in the box, with from 20 to 30 tons pressure, it will be readily seen that with this inadequate bearing on the edges, it is impossible to keep shells tight; a width of one and one quarter inches would scarcely be sufficient. They are not made heavier because the driving box is not wide enough to admit of cutting out, it would be weakened too much. After these shell bearings are finally in place we have no confidence in their remaining; we put a couple of ¾ or ⅞ pins through the box and shell to hold in place, further weakening the box with the holes, which, in conjunction with the driven pins, make a good starting for a fracture. A better shape in every way for journal bearing in driving box is what is known as the hexagon; this form can be fitted into the box without pressure; having no strain on the box it can be made lighter than the shell, and yet have more metal at the bearing points; by casting lugs on the top angles seven-eighths or one inch wide on bearing and corresponding recesses in the box, it is held in place with no further trouble. The cost of properly fitting this bearing in is more than the shell bearing, and final result is more satisfactory.

If the half round bearing is to remain as a fitting of locomotive driving boxes, a radical departure will have to be made, in increasing width of pedestal openings to admit of wider boxes and heavier bearings which have got out of proportion to the heavy engines, larger driving shafts, higher boiler pressure and greater speed of modern practice.

Your committee are aware that there are other forms of driv-

ing-boxes with brass and cast-iron gibs; as there are but few, and those going out of service, have not discussed their merits. At present the journal bearings of driving-boxes are made from bronze and brass. Those who are using bronze speak highly of its merits as a bearing. Those who are using brass are equally sure it is the best metal for the purpose. There are no records to show which of the two metals is actually the best for the service, and gives the best results. There are a number of mixtures for brass of driving-box bearings; those in use by roads of the largest mileage are as follows: Three, 6 parts of copper to 1 of tin; one, 6 parts of copper to 1 of tin, quarter pound of spelter; one, 7 parts of copper to one of tin, adding one-quarter pound lead; two, 7 parts of copper to 1 of tin; all report good results from these bearings. It is generally accepted that good results are obtained from hard bearings; but as the bearing is hardened, the danger of breaking increases; if the bearings are soft, they crush out.

Your committee are of the opinion that no fixed rule can be given for proportion of parts in brass used in driving shaft bearings for all classes of locomotives. The mixture must be proportioned to the weight carried. Engine truck boxes made of cast iron will answer every purpose. The journal bearing should be of hexagon pattern fitting freely into the box.

Such good results are obtained by casting the bearing, that no fitting is nece sary. The reason of this is, that the weight now carried on engine trucks of the heavy four-wheel or American class of locomotive is so great that truck may spring from shocks due to high speed. If shell bearings are used with close fitting boxes, heating is sure to result; when the bearing is loose in the box it will remain on the journal, and not be affected by the spring of the truck frame and braces. The hexagon truck bearing is fastened in box by lugs cast on angle on top side of bearing, which fits into corresponding recess on the inside of truck box. The general practice is to make these bearings of brass; some roads use bronze. The composition where brass is used on roads of large mileage is as follows: One, 7 parts of copper to one of tin, and one-quarter pound lead; three, 6 parts of copper to one of tin; one, 7 parts of copper to one of tin; one, 9 parts of cop-

per to one of tin ; one, 6 parts of copper to one of tin, and one quarter pound of spelter.

All report good results from these compositions.

Your committee are of the opinion that the difference in the composition is due to the weight carried ; where increased proportion of copper is used the weight is probably light ; the copper is reduced as the weight increases; the committee have no information as to these weights. Brass bearings lined with lead give good results when weights are not excessive. It has been found that with 28,000 and 30,000 pounds on truck, the lead will crush out at the ends and sides of bearing; this can be overcome by adding tin or antimony to the lead ; when this is done the metal becomes brittle and shells off. In case of hot journal, the lead melts, filling up the oil-holes and cavities, making it impossible to get oil to the journal, resulting in trouble and delay. Strips of Babbitt metal one inch wide extending the full length of the bearing give good results, running cool and increasing the life of the bearing.

Your committee have not attempted to give dimensions or go into details, as there are now so many different classes of locomotives in service, working under ever varying conditions, which must be met and provided for, and can not be governed by fixed rules covering all classes and conditions.

They hope that this report may be suggestive and bring value to the Association.

WM. BUCHANAN,
JNO. W. CLOUD, } Committee.
J. M. BOON,

Motion to receive report was made and carried.

DISCUSSION ON DRIVING BOXES.

THE PRESIDENT—I suggest that Mr. Boon, who is one of the oldest members of the Committee and very familiar with the subject, open the discussion. I know the members would all like to hear from him

MR. JAMES M. BOON—The report in the first place speaks of making driving boxes of cast steel. Those members who have had experience with cast steel driving boxes are no doubt familiar with the trouble of hubs wearing away and also the steel. Cast steel and cast iron will not work together. You can not possibly work cast steel cross heads without putting a cast gib on, and it is the same with the rubbing surfaces of an axle box and wheel hub. A brass

plate may be put on the hub but to do that is starting the trouble again. It is a difficult matter to get a plate that will remain. That is, the space is so contracted that you have got to put in a very thin plate. If you wish to get in as wide a fire box as possible you have got to put a thin flange on and to start with a bad job to begin with. I have had considerable experience with steel boxes and find no benefit from them except that you can use a light casting. Another trouble develops also in cast steel—when I use the term shell—it is a brass pressed in. When that is used it will sometimes get hot; when it heats, the cast steel will heat more than the brass. In other words, the steel will expand more than the brass will. The consequence will be that the brass will get loose in the box and the box will pound on the brass. You have to be very careful in adjusting the wedge on a cast steel box, for if the wedge is set up too tight, on heating it will jam. If it is set up too loose it will pound. Cast iron, when you can get it in strong enough, is good material. But we all know the engines are increasing in weight and increasing in size, and that the pedestals are kept the same size. The consequence is we want something very strong for boxes. Some people put a large cylinder on and they get a larger driving shaft and the consequence is the box is so weak that it breaks and in that way troubles never end That brings us down to making the driving boxes out of some solid metal and avoiding putting in shells. Long experience demonstrates that the best bearing to put into a driving box is the old-fashioned hexagon-shaped brass. By fitting that in you get the best results by planing the box out carefully. It has to be a good job fitting the shell so there is no strain on the box. You then have a box to run for years. It is necessary to be very careful in fitting the parts in.

When you come to think the matter all over, while we are making a driving box why not make it out of solid metal? Then you save the trouble of fitting. You save fitting the parts, you save the annoyance of a cleaning and the only additional cost is the first cost. Then you get increased wear. You simply take the box, bore it out and fit it in your shop. You have got a box there that will run. I have run them for five years. After the box is worn, which will only be when it has worn its way to the top of the box, you have material enough very near to pay 75 per cent. of the cost of a new box. I would make it either out of bronze or out of a composition. Then another thing that instigated this Committee more than anything else was the fact of hot boxes. When you use the word brass or composition it is very indefinite. You can make a dozen different compositions, but the brass that we use to-day on a locomotive has got to be a different brass from what we used twenty years ago. We are carrying more weight on them and we are running the engines at higher speed. Twenty years ago it was a rare thing to run a train to exceed twenty miles an hour; thirty miles an hour was a terrific speed. To-day the road that can not take ten or twelve cars and make forty miles an hour and keep it up for 500 or 600 miles is not considered much of a road. Twenty years ago you were probably carrying 20,000 pounds on your drivers. To-day you are carrying 40,000 pounds, and exceeding that, and you have got to get a brass that will carry that. The

bearings have got to be hard. When you get the bearings hard you run into another difficulty. If you get the bearing too hard it will break. It is a very nice point to find out just where that breaking point comes in, but we must keep the brass or bearing whatever it may be, as soft as we possibly can. It must not cut, or crush out, and at the same time be strong enough so that it will not break. When we look up the matter of the different alloys, and find out what amount a certain alloy will carry to the square inch, very little reliable information can be got. One way is to make observations and try and see what an alloy will do—make a text book of your own.

With an ordinary cast iron truck box we get good results, but the trouble with truck boxes is generally that the journals are too small. You have got a small wheel on here. You find engines running high speeds with a 26 inch and 28 inch wheel. The velocity of those wheels at 40 miles an hour is something appalling. The old trouble with shell brass comes in fully there, with the additional trouble that the engine trucks to-day as a general thing are too light. When we think of the weight of iron that you used in the locomotive twenty years ago, the size of the frame, etc., and then measure the truck to-day of a 45 or 50 ton engine, you will be astonished to see what a little difference there is, yet the difference in weight is very great. Now we have got those engines we can not throw those trucks away, we have got to work them in. They get hot. On examination we have found that those trucks would spread. The consequence is they run hot. They have not got bearing surface. The only way to get over it, is to make a brass that will accommodate itself to the truck ; then fit your box loose from the pedestal ; then when the box gets springing it will accommodate itself to the work, and you will have no further trouble,

Another very important point bearing upon this is that frequently you have trouble in heating. The first question is, what is the matter with the oil? Nothing is the matter with the oil. Then, what is the matter with the brass? Everything is done and still it is heating. Frequently it has been discovered that the cause of heating reaches away back. Take a locomotive engine and the weight on each one of the boxes should be the same ; but a spring breaks some day. There may be a 13 leaf spring break. They have not got a 13 leaf spring, and they put in a 14 leaf spring. The consequence is it gets out of adjustment and gets hot in spite of anything you can do. Or a hanger breaks and the engine is drawn out of adjustment again. The same with the truck. One spring is put on one side different from the other and heat results. It does not make any difference what the load is, or what the oil is, unless all the points bearing on that are equally good and there is proper adjustment, you are going to have trouble. That has been my experience and I think most of us here who have been through the mill will bear me out.

MR. LYNE — I would like to say a word as to the treatment of these bronzes. Those who are using brass are sure that it is the best metal for the purpose, and so with reference to the bronze. And more depends on the molder in the handling of these metals, phosphor-bronze particularly, than you might at first suppose. Phosphor-bronze melts at a much less temperature than ordinary

bronze. For instance, I have known a piece of ordinary bronze or composition to have accidentally got into the pot with phosphor-bronze. The phosphor-bronze was melted, and when they came to pour the metal out, this piece of composition was found still in a solid state at the bottom of the crucible. Now in pouring the metal, if you notice closely, the stream breaks off, as it were. There seems to be a scum on the surface. After the casting comes out, if you will examine the face of the journal carefully, which is usually cast with the face downward, you will find spots that can hardly be touched with a file. Now, if such a bearing is put on a journal and run in that condition, the surface of the bearing is reduced. In other words, the bearing comes on those hard spots. I know of one concern that has adopted the plan of having the castings examined carefully by a man who cuts out these hard spots with a chisel. In reference to the phosphor bronze, it is necessary that the molder understand it thoroughly, in order to get the best results; to have it thoroughly stirred up and fluxed properly while it is in the crucible, and not to over heat. For instance, I have known a pair of brasses on the front end of an engine to run fourteen months without being touched. On another engine, and under the same conditions, apparently, they would not run a week. There is the secret — the molder did not understand the mold properly, or he allowed it to get very hot and did not keep it properly fluxed.

In reference to the hexagon form of box. I would say that in my judgment it is well to take off the sharp corners and leave a fillet. If you remove that sharp corner, there can be no place for the vibrations to concentrate. You will notice that these cast iron boxes which break in the corners, if you leave a fillet there and take the corners off, it takes the strain off the box.

On motion, convention adjourned for the day.

SECOND DAY.

The Convention was called to order at 9.25 A.M.

DISCUSSION ON REPORT ON DRIVING-BOXES—*Continued.*

THE PRESIDENT— The first business in order this morning, is a postponed discussion on "Driving and Engine Truck Boxes; best form and size in proportion to cylinder."

MR. WM. SWANSTON—I have had a great many engines with the hexagon box. As a personal preference, I rather think it is about the best box when properly fitted up. The shell box, however, is the standard we use, and we are putting it in. I still think that the hexagon box, when properly fitted, is fully the best box and gives least trouble. I think, however, that the idea that was presented yesterday, that it is about the same in cost, is a mistake. The hexagon box will cost nearly double as much to fit up.

With regard to truck boxes, the hexagon box is decidedly the best box in my opinion. We have the shell box. We have also the brass gib on top, and the slips of Babbitt metal on the side, but the ordinary brass, and box of hexagon form, made so as to fit the casting without the extra fittings, is decidedly, in my opinion, the best form of engine truck box, not only as regards its wear but the convenience of replacing it when worn out. We have a number of our truck boxes that are fitted with shells. In case of a box giving out that is worn out, probably there is a delay of the engine for a trip. With the hexagon box, the matter can be all replaced and put in good shape in half an hour. My preference would be for the cast iron box, so far as the hub wear is concerned. We have a number of solid bronze boxes. They are the best box that I know of. They are more expensive. It is only a question of dollars and cents. But a solid bronze box without any fitting whatever, is decidedly the best box. If you are going to use cast iron, I believe a hexagon brass is the best.

MR. JOHN HICKEY—I would like to inquire whether any member has had any experience in driving boxes, fitted up with brass gibs, set into the driving box, with the intervening spaces filled up with Babbitt metal. I have tried brasses and driving boxes in a great many different ways, but I have found that means to be more effective, although a little more expensive than the other; it gives better wear. I would like to hear from some other member on that.

MR. SWANSTON—There are three brass gibs on top and on each side, and Babbitt metal between—yes, I should say I have used it—so have you [addressing the President]; but I do not like it.

MR. ALLEN COOKE—I have had experience with the hexagon brasses. We have tried them a great deal, and had a good many engines with them in, and we had a good deal of trouble. We have now as a standard—a round brass well fitted in, and pressed in at about nine tons pressure, and we get good results.

SECRETARY SINCLAIR—The report emphasizes the preference of the Committee for boxes of the alloys of copper, and I think the Association ought to pay some attention to it, or express their views about that point. Those who have tried brass and bronze boxes are nearly all highly favorable to them, and although they are expensive in the first instance, they are certainly cheaper in the end, and they are thoroughly reliable. They have had a very thorough test on the hard-worked engines of the elevated system in New York. They started out with an ordinary cast iron driving box and brass bearing, and they had no end of trouble in keeping the engines going. Then they adopted brass or bronze boxes—I guess a bronze box—and they have not only been saved a great delay of their engines, but the expense is much lower than it was with the other form of box, and they have been so successful that I think the surface roads ought to direct attention to the advisability of doing the same thing.

MR. H. N. SPRAGUE, Porter Loco. Works—I would like to ask if you do not find some difficulty in getting end-play with bronze boxes. My experience is that where cast iron will wear without cutting it will wear longer, and wear slower than brass or composition of that kind. I should think you would be more likely to get end-play with a bronze box than with a cast iron box.

MR. J. N. LAUDER—I have had experience with different metals in driving boxes, and I think it is safe to say that the lateral wear is very much less with a good cast iron driving box, than with any other metal that you can possibly put in. The brass will wear very much faster than the cast iron. Steel will not do at all; that is practically out of the question. You can not run steel against a cast iron hub, without its wearing away very rapidly. Where parties are obliged to use steel to get strength on account of a badly designed box, they must protect the wearing surfaces of the side of the box with either cast iron plates or bronze plates—preferably cast iron. A plain cast iron box of sufficient weight and strength to stand the strains, with a good composition shell in the form of a half circle, well fitted, I think without doubt is the best form of driving box.

MR. MACKENZIE—The thought occurred to me, Mr. President, that in condemning these steel driving boxes, nothing has been said as to planing them up laterally. It is a question in my mind, if the box had lateral motion enough when first applied, that it will not give us a great deal better results than we get with cast iron or anything else that is fitted up close. We have some engines that are badly designed in the driving boxes, light flanges, and they are continually breaking. I have thought very seriously of trying the steel box, and when I try it I propose to give it as much lateral motion as the engine will wear in six or eight months, or take the wear off before I put them in. I am

of the opinion that if that is done, there will be no trouble with steel boxes or any other box. It is simply a matter of whether you will take it off in the first place, or allow the engine to grind it off. Some two or three years ago I advocated getting them up pretty close; but I have come to the conclusion that I was wrong.

MR. J. N. LAUDER—There is one thing that perhaps might be said in favor of what we have always called the old fashioned driving box, with three or four brass gibs set in, one perhaps at the top and one at each side, and the space between, filled with Babbitt. With that form of box there is no danger of spreading the box at the bottom and getting the sides out of parallel. Now, with the box that is almost universally used to day—the half-moon shell forced in—there is danger of spreading the box at the bottom, and when it is put in between the shoes on the jaw, you will not have a good fit. As the brass wears, and the box is subjected to the strains of service it gradually comes back to its original form where it was when it was first planed off. Then you get it pinched at the top, and loose at the bottom, perhaps. Now, the form spoken of by Mr. Hickey has a good many advantages, and that is one of them, that you can put these gibs in as tight as you please, and there is no danger of spreading the box and getting it out of shape. Away back in the early days, most of the driving boxes that I am familiar with, were fitted up in that way, and they did good work ; but it was discarded because of some supposed advantage, that the solid brass had over the old method of putting in gibs and Babbitt. I do not know whether the matter of running solid brasses, or brasses with soft metal linings in them has been touched upon ; but I have only to say that I have tried several times in the last ten years to run solid brasses, and in every instance failed. I have been unable to make them give me a satisfactory service, to wear as well, and run with as little liability to heat, as where we put in strips of so-called Babbitt metal.

MR. F. B. GRIFFITH, Delaware, Lackawanna & Western—We have a class of engine that have the springs hung from the bottom of the driving box, and we have tried to use cast iron boxes. They are not strong enough to hold the weight. Then we resorted to a solid metal box—brass, and we find that the men will occasionally get careless with their boxes, and they will get heated, and it is very expensive when we have to throw one of those boxes away, so we have run, this last year that class of engines with very good results on a steel box and we place a ⅝ plate on the side of the box with countersunk bolts or studs in them of brass. Now, I find that our composition boxes cause less wear on the hub, than our cast iron ones did. It is only a matter of lubrication in there. If there are proper oil creases put down the side of the boxes, with those steel boxes we can have a heavier wedge than we could with the cast iron ones, and I am very well pleased so far with the result of them.

MR. J. S. MCCRUM, Kansas City, Fort Scott & Gulf—In connection with the subject of lateral wear I would state what my experience and practice have been for a number of years. In taking up the lateral wear on driving boxes, I use Babbitt metal. For instance, a box comes in worn laterally, and if the

flange or side of the box is heavy enough, I counterbore in just enough to give the Babbitt metal a hold. Then I set in some brass pins, and then I tin the face of the box and cast the metal on and plane it off. When I first saw that practiced some ten or twelve years ago I had little faith in it. I had no idea it was of any merit at all, but in all the experience I have had, I have never found anything that is equal to it. It may be said if you get a very hot driving box you will melt that metal, I have known in my experience one or two cases where a box got hot enough to start the metal ; but it takes a high temperature to melt a good Babbitt metal, and I find very satisfactory results that way. Mr. Briggs, I expect, has observed some of the operations of those boxes on our line. He has seen engines fitted in that way, and I think perhaps he will give us his views on the matter.

In reference to steel driving boxes, I have never had any experience with them, but I should be very much afraid of using a steel box without protecting it laterally in some way, and I do not know whether or not the effect of the wear of the box on the wedges would be satisfactory. But if I was going to try a steel box, I think I should face it with Babbitt on the sides. I am satisfied that any gentleman who once tried that method of taking up lateral, both on driving and truck boxes, will never use anything else.

MR. R. H. BRIGGS, Kansas City, Memphis & Birmingham—As Mr. McCrum remarked, I have tried that style of casing on the driving box. Before going to the road I am on at present, I did not have much faith in it, although I had heard of it several times; but I had occasion to notice several boxes that had run a considerable number of months with that facing, and I was very much surprised at it. Upon seeing what it had done on the driving box, and being a long distance away from foundries and machine shops at that time, I had to take care of a good deal of lateral motion on our engine truck boxes. I could not turn them around and get the proper distance between hubs, so I concluded I would try a Babbitt facing to overcome the difficulty, and to my surprise it stayed there. It is there yet, and it does not show as much wear as we see on an ordinary cast-iron box. It is the best thing I ever saw.

MR. H. N. SPRAGUE—I would like to inquire in reference to Babbitt. It goes through a great range. I suppose you mean a cheap metal; not a metal of a copper mixture. I do not understand that that is used to any extent; that it is more like type metal. My experience is that with genuine Babbitt metal, a mixture of copper and tin, that it will wear a pin faster than anything else. I have taken genuine Babbitt out of brasses to prevent wearing the pin. The Babbitt would wear the pin so fast as to make a shoulder there right away. I have not for many years, except on high speed machinery, used any mixture of copper in Babbitt. I have used a cheap grade of what is called Babbitt metal, but no copper.

MR. LEWIS F. LYNE—The varied experiences of engineers in the use of Babbitt metal, the failure and success that they report, are largely due to the manner in which Babbitt metal is applied. Some people have an idea that you can pass Babbitt metal into the face of a brass and get good results by just

pouring it into a cavity and letting it cool off. Now, that is not so. You may get good results, but the probability is that you will not. The natural shrinkage of the metal will leave that Babbitt, if not loose at first, at least so that it will become loose after it has been in use a little while. Now, when I speak of Babbitt metal I mean Babbitt metal, compounded according to Isaac Babbitt's formula—4 pounds of copper, 8 pounds of antimony and 96 pounds of tin. The metal was made of 24 pounds of tin at first. The additional tin was used afterwards to make the lining metal. Now, the Babbitt metal should be put in hot, so that it amalgamates with the brass or adheres firmly to it. Now, I have never know Babbitt metal so applied to fail, if it was properly oiled. I have run, for instance, the driving brass of the main rod of a stationary engine for two years without touching it, and as is demonstrated on the Porter-Allen and some other high-speed stationary engines, it is found that the wear of good, first-class Babbitt metal is almost imperceptible with good lubrication. The Edison Machine Company are making a success of a form of bearing which was discarded years ago as being of no use. It is a cast-iron shell with spiral grooves running through each end towards the center of the bearing. Into these grooves is poured Babbitt metal formed into strips. Those strips have become loose, so that the bearing was actually on the cast iron instead of on the Babbitt metal. To overcome this difficulty, they now bore the cast iron shell, pour in the Babbitt metal, then bore the Babbitt out, leaving a thirty-second of an inch extension. Then they expand the Babbitt so that it completely fills the grooves, so that there is no danger of it getting loose. In cast iron bearings, where it is not possible to tin the surfaces, the Babbitt metal should be compressed in some way, so as to entirely fill the cavity. Otherwise it will become loose, and you will have the bearing all on the brass and very little on the Babbitt metal. The same way in the case of composition packing rings, which used to be used more extensively. Babbitt was poured in, and it shrank and got loose and was of no practical use; but where it was tinned and put in in that way it was part of the same casting, and, of course, you got the benefit then of the anti-friction character of the Babbitt metal. Of course, to pin the Babbitt metal with a hammer helps it to some extent, but a steady pressure such as I speak of fills the cavity thoroughly.

There is one other point with reference to the filling of these grooves in journal bearings. Take a composition journal bearing with those grooves in and it is almost impossible to get the sand out of them. They are cleaned in the foundry with a brush or the end of a file or some such rude instrument, and there is sand left in there, and the result is that the sand generally comes on the journal bearing as the bearing wears away, and that sand will cut away the journal bearing and a good many people think it is the Babbitt metal that does it. The proper way to clean the sand out of those grooves is to use the sand-blast, which will take out every particle of sand. You take a sand-blast, and by firing those particles of sand into those grooves under a high pressure, it cleans them so they are thoroughly bright. Then tin the grooves, pour in the

Babbitt metal, and I am convinced you will not have any trouble from pins wearing away.

MR. SPRAGUE—I think that point is well taken about sand in a cast recess. Of course, I do not use Babbitt in driving boxes, but in my rod brasses I cast them solid and drill the holes. I drill every other hole at one angle and every other hole at the opposite angle. I think really it pays. It does not cost much more to make sure to avoid all of that sand which is liable to be in those recesses.

MR. HICKEY—Returning to the manner of placing the brasses in the driving box,—it is stated by Mr. Lauder that it is a very old style. I admit that the plan is a very old one, but I think in the old plan there were but three pieces of brass dovetailed into the casting, and they had consequently a large amount of surface. In the recent plan we have adopted, we have placed five of these strips in the driving boxes, and placed a good quality of Babbitt metal —metal that will not run until it has reached a high temperature—in the intervening spaces, and we have engines which have a weight of 12,500 to 13,000 pounds on those boxes, and they give better satisfaction than any other class of box we have. They are giving excellent service and we are very much pleased with them. Speaking of Babbitt metal, I think a good Babbitt metal of a high grade is harder than the lower grades usually, and a great many people think because they have a low grade of metal it appears to wear better—with less friction. I think that is true; but it is owing to the fact that the metal is softer and admits of a better lubrication, but when this higher class of Babbitt metal is properly lubricated there is nothing I know of that runs better or as well.

MR. L. C. NOBLE, Houston & Texas Central—On this subject of driving brasses, a number of years ago I fitted up a few engines the same as Mr. Twombly, of the Rock Island, slotting the box, fitting the gibs in nicely, and Babbitting in between. I fitted up four engines and ran them a year. I had trouble in keeping them tight. I then cast my gibs in the box; before putting the brass in the mould, cleaning it up on an emery wheel to get rid of the sand, and inserting them in the mould and securing them in that way. I fixed up four or five engines in that way, and had no trouble with the brasses getting loose. I filled in the Babbitt, cleaned it down, bored out the box, and ran them I think fifteen months without any indication of looseness and with but very little wear. When I callipered my journals I found that the wear was in the journal. I would like to ask Mr. Hickey what result he got on the journal.

MR. HICKEY—I have not noticed any more wear on the journals. We have metal in all our driving boxes. We introduce strips of metal—a strip on each side of the crown and I have not seen any more wear, although we looked for it, with this style of box, than I have with the other.

MR. NOBLE—With my journals I can run a seven inch journal. If they had worn as much in the three years as they did the first it would have reduced the journals $\frac{5}{16}$ths. I took them out. We are now running a solid brass with a little strip of Babbitt.

MR. COOKE—I would ask Mr. Noble whether he put in three gibs or more?

MR. NOBLE—I put in five gibs.

MR. J. C. RAMSAY, Illinois Central—We are using a box of this character on the Illinois Central road. We are using it on some of the heavier engines on the Northern Division. Now, I am putting it on our Southern Division. At first when I had that box explained to me I got four pieces. I made a little mistake in it. Our object was to cast the gibs in and then when the box became a little loose on the journal we could drive these gibs out, and you can force them out under a heavy pressure. Then insert new ones on the sides, re-bore the journal and put them under. Now, since the first six I put in, which was somewhere over six years ago, those engines are still running and have not given any trouble. The Babbitt filling, as a matter of course, is between the gibs. The only difficulty I found was in casting the brass box. We had too many pieces. Since that time Mr. Schlacks has instructed me in the matter and sent me some boxes with three pieces, which give a greater bearing surface. This box, I understand from him, has given general satisfaction. In fact I have been so taken with it, that I have asked him to furnish me with the same box from Chicago for my different styles of engines,and I have found good satisfaction.

MR. A. DOLBEER, Rochester & Pittsburgh—I was brought up on a solid half circle box. In fact I was so innocent a couple of years ago that I thought nothing else would run satisfactorily. But I came on to the Rochester & Pittsburgh and found a class of engines there that were equipped with a three gib box with Babbitt in between. I looked at those boxes, and I thought there was going to be a chance for me to immortalize myself. Somewhat to my surprise I discovered that when those engines were in for repairs we had no trouble with the driving boxes. Now, that was a staggerer to me. In an experience of quite a number of years, I never expected to raise an engine off the driving boxes without having to consider the question of considerable importance, of whether we could manage to close those shells or whether we would have to put in new driving boxes. The consequence was, as I say, to my surprise — I will not say to my disgust — mind you, I was going to immortalize myself by putting in these solid shells into the boxes, and they already have a much better wearing arrangement. Now, I have got so far converted that I am changing engines just as rapidly as possible. Of course, we have none that are suspended from the bottom. We are simply using now a box with three gibs, Babbitt in between, and we are fitting them up, and we are getting along. In fact. you can not imagine what a relief it has been to me in regard to the driving box question.

MR. NOBLE—I would like to ask the gentleman what his experience on the journal wear has been.

MR. DOLBEER—Well, we do not need any re-fitting. I have not made any special tests of journal wear because there has been no reason for it. But I do know about journal wear that it is less, or if it is not less it is no more, because we find in ordinary cases that an engine that has run a year with pretty hard service, I will say in most cases need nothing done to the driving boxes. Another thing I would say, we do not have the amount of lost motion on our driving box, that there has been with other boxes. In reference to the solid composi-

tion box, I will speak of the experience of a number of years ago, and I never realized any very good success. I had seen a solid composition box — perhaps it may have been the fault of the composition—I had seen it raised after it had been put on an engine, inside of a month, and I found nearly $\frac{1}{16}$ of an inch lost motion in the box. You know when there was wear to take up, the old plan was to get them out and put them under a steam hammer. You manage to break one box in about five by that method, and usually after that is done I think they wear a little bit better. Possibly these boxes not giving satisfaction may have been the fault of the composition.

MR. MACKENZIE—My experience has been with the solid brass, that the less the Babbitt the better the bearing. We use Babbitt in our brasses, but just enough to keep them from running hot, that is all, and we place the box in a slotting machine and circle it out to a true circle. Take the driving box, place it on a planer, and take the scale off all around. Then press the brass into the driving box at a pressure of about nine tons. We have taken all the spring out of the box, and after the brass is pressed in we plane the box up and have no trouble with them afterwards. My experience has been that the parties who advocate Babbitt metal advocate the wear of the journal. In other words, they use Babbitt metal at expense of the iron. The more Babbitt metal used, the more iron is worn out. We have got driving axles on our roads, I think, that have not made over 200 000 miles, that are worn over $\frac{7}{16}$ths of an inch, caused by the three gib box—too much Babbitt. Now, I think a solid brass properly fitted up, circled out, as I say, is better than anything we have had. That has been my experience for a good many years. I think that Mr. Hickey is coming to the solid box by advocating five gibs. After that he will use six and then he will discard the gibs altogether. A great many say that three gibs are good enough. Mr. Hickey does not think so. He thinks five are better. He is removing the Babbitt. The more Babbitt he removes the better off he will be. Our Babbitt strips are $\frac{3}{8}$ths of an inch wide and set probably an inch and a half from the center each way. We only use it for reducing the friction; that is all—just enough to lubricate the axle.

MR. WILSON—In regard to the three gibs or the five gibs, I would say that we have had a great deal of experience on our road for the last fourteen years, and I guess we have over 200 engines running now with three and a few with five gibs. But our experience, I think, agrees with that of everybody who has had any length of experience, that the longer you use them—that is in comparison to a well fitted half moon brass—the less you like them. That is my experience. A gentleman spoke about immortalizing himself by putting in half round brasses; there were men in our system who thought they were immortalizing themselves as they ran on to the three gibs, and they did not do it; but we have run them very successfully. We have engines on our road that had the three gibs when Mr. Mackenzie was on it, and which are still rnnning with them, and are running very successfully. I have no use for this hexagon one either. I mean by that, it is more expensive to fit up and harder to take care of than the half round brass. Now, if you get that, in our experience you get the

best that is going; but we find on our road that we need a little Babbitt on each side of the bearing, just as Mr. Mackenzie speaks of, only a little wider strip, because we have more sand and less rain than he has, perhaps. After what I have seen in the last fourteen years, if a man would offer to fit me up a set of driving boxes with Babbitt in them I would not take them as a gift. I would be excused, because with engines running side by side, the heavier the weight and the higher the speed, so much better will they show up with a well fitted half round brass.

MR. WILLIAM MONTGOMERY, Central of New Jersey—I have had some experience in the use of the old fashioned hexagon brass, and the half round brass, and also the gib brass, and the trouble with the old hexagon brass was the tendency to get loose in the box, and pound. Oftentimes it was necessary to remove them before they were worn out. With the half-shell brass we had considerable difficulty in their getting loose, particularly where there was any tendency to heat. The brass would stick on the journal, and the result would be that there would always be a loose brass causing a good deal of pounding and annoyance, and often making it necessary to take the box out, before we could get it down to a good bearing or in good running order. In nearly all cases in taking out those brasses, in putting them in and slotting them out, and carefully fitting and putting in at a pressure of ten tons, we found them loose. After receiving some engines from the firm that put in the three gib brasses some fifteen years ago, we found those brasses gave us less trouble than either of the other brasses. Of course, as Mr. Mackenzie has said, we found that there was considerable wear to the journal. We found that those axles and journals wore a great deal faster than where we used a solid brass. either the hexagon or the half round; but by altering the gibs and bringing them closer together, we reduced the difference very much and reduced the wear, and we have been putting in the three gib brasses by slotting them out and getting a good solid bearing. Some have been running for years and years, and giving us very little trouble. There is no tendency in fact, so far as I know, for those brasses to become loose, as they are well backed up by a good solid bearing. As I said before, the journals wear faster; but it is a question whether it is not better to renew your axles oftener and get more mileage out of your boxes without being required to take them out and renew the brasses, or remove them to take the pound out, tighten them up in the box, or put in new brasses.

MR SPRAGUE—I do not like to choke anything off, but it seems to me if this thing is going to take this turn we ought to have a committee on it. We can not afford to debate this all day. I move therefore that the discussion be closed.

The motion was carried.

EXHAUST PIPES AND NOZZLES.

THE PRESIDENT—The next subject in order is the report on "Exhaust pipes and Nozzles. Best Form and Size in Proportion to Cylinder." which was passed yesterday. Is the Committee ready to report this morning?

SECRETARY SINCLAIR—There is no report from the Committee, and I hear from gentlemen about that none of the members will be here. Something unexpected has prevented them from attending; therefore, I think it would be advisable to continue the Committee.

MR. SPRAGUE—I move in that case that the Committee be continued another year.

The motion was carried.

THE PRESIDENT—The next business will be "Boiler Coverings; Best Method and Material to Prevent Radiation of Heat." The report is in the hands of the Secretary.

Secretary Sinclair read the report, which is as follows:

BEST BOILER COVERING.

Your Committee, intrusted with the subject of report on "Best Boiler Covering," beg leave to submit the following:

The predominating covering is of pine wood, secured to flexible wooden hoops encircling the boiler; thus leaving an air space between the covering and boiler to the extent of thickness of the hoop. This space is generally agreed (by experimenters) as conducive to the best results, but that its effect is dependent upon keeping the air in the space in a quiescent state.

In considering the first cost, wood covering is the cheapest, but is comparatively short lived; and, if not kept strictly in repair, rapidly parts with its effectiveness, and in the end is undoubtedly a costly covering.

Composite and sectional composite coverings are meeting with considerable favor; the former being applied in a plastic state, and in immediate contact with boiler. This method provides no air space, and is questionable as to producing the best results with covering of any kind. The annexed engraving and drawings submitted give particulars and manner of applying composite sectional coverings, and attention is called to that of the silicate cloth, as having the appearance of effectiveness and monumental durability.

With whatever covering used, it is always in the interest of economy to first apply to the boiler a coating of non-conducting,

non-corrosive material; for which plaster of paris appears to be well suited; the application being made by mixing with water and applying with a brush; and, in consequence of its rapid drying qualities, several coats can be quickly applied.

The subjoined table, taken from the *Railroad Gazette* of April 20, 1887 (Experiments on Loss of Heat by Radiation, by Mr. J. C. Hoadley, of Lawrence, Mass.), gives unmistakable evidence of the economy in covering boilers:

1	2	3	4	5	6	7
Pressures by steam gauge, pounds per square inch.	Computed time in minutes of increase in pressure.	Observed time in minutes of increase in pressure.	Loss of pressure by radiation from naked boiler in minutes.	Percentage of loss with naked boiler.	Loss of pressure by radiation from clothed boiler, in minutes.	Percentage of losses with clothed boiler.
0 to 10	5.0	7.5	----	----	----	----
10 to 20	3.5	4.3	----	----	----	----
20 to 30	2.8	3.3	----	----	----	----
30 to 40	2.3	2.5	----	----	----	----
40 to 50	2.0	2.1	----	----	----	----
50 to 60	1.8	1.9	18.0	10.6	41.1	4.6
60 to 70	1.6	1.8	15.0	11 3	37.5	4.5
70 to 80	1.5	1.4	13.7	10.2	32.5	4.3
80 to 90	1.3	1.3	12.1	10.7	29.9	4.3
90 to 100	1.2	1.2	10.9	11.0	24.3	4.9
100 to 110	1.2	1.2	9.4	12.8	21.0	5.7
110 to 120	1.1	1.1	8.5	12.8	19.2	5.7
120 to 130	1.0	1.0	7.6	13.2	18.8	5.3
130 to 140	1.0	1.0	7 3	13.7	17.3	5.8
Mean.	----	----	----	11.8	----	5.0

The following extracts from the *Gazette* editorial commenting on the experiments are of value, on account of their pertinency to the subject in hand. It is stated that:

"The experiments were made with a 60 horse power portable engine and boiler, of which the following are the principal dimensions:

Cylinders	$12\frac{1}{2} \times 18$ in.
Inside diameter of barrel of boiler	38 in.
Thickness of plates	$\frac{3}{8}$ in.
Size of fire-box, inside	54×33 in.
Number of flues	63
Size of flues	2 in diam. $\times$ 9 ft. long.
Total heating surface	402.23 sq. ft.

The method of making the experiments is described as follows: 'After the boiler of this engine was tested with 150 pounds pressure and without being covered, steam was reduced to atmospheric pressure with water at about the nominal water line ($2\frac{1}{2}$ inches above the top of the crown sheet), and a good fire of dry wood was started, with the safety valve wide open. When the fire was at its hottest, with a good mass of glowing coals and partly burned wood at the bottom, the fire-box was filled with a compact firing of dry wood and the safety valve was closed.' The time required for each ten pounds increase of pressure was then carefully noted.

"It was assumed that the heating value of the fire was sensibly constant during the period of time, 32.4 minutes, occupied in raising steam pressure from 0 to 140 pounds pressure above the atmosphere. Although the assumption can hardly be exactly correct, it was shown that for the purposes of the experiment it was quite near enough. This was done as follows: As the weight of the water in the boiler and that of the boiler itself and its attachments, which were heated by the steam and hot water, were known, and as we know how much heat measured in thermal units is required to raise a given weight of water from a temperature of 212 degrees, the temperature of water under steam of atmospheric pressure, up to the temperature due to the pressure of 140 pounds above the atmosphere, and as the specific heat of iron is also known, we can tell how many thermal units will be required to raise a given weight of it up to the same temperature.

"The quantity of heat thus transmitted to the water and the boiler was calculated in this way, allowance being made for the modification of the specific heat of the water by temperature, and the 'augmenting weight of steam in the steam-space and its diminishing ratio of increase of heat.' When the total quantity of heat contained in the boiler and the water, and the number of minutes required to transmit it are known, it is of course easy to calculate the number of units of heat imparted per minute or for

any other time. With these data, the time required for each increase of 10 pounds pressure was computed, and is given in the second column of the table, with the observed time in the third column, as indicated by the experiment. The results are given in the fourth column of the table, and should be read from the bottom upward.

"Mr. Hoadley remarks: 'There are some slight irregularities,

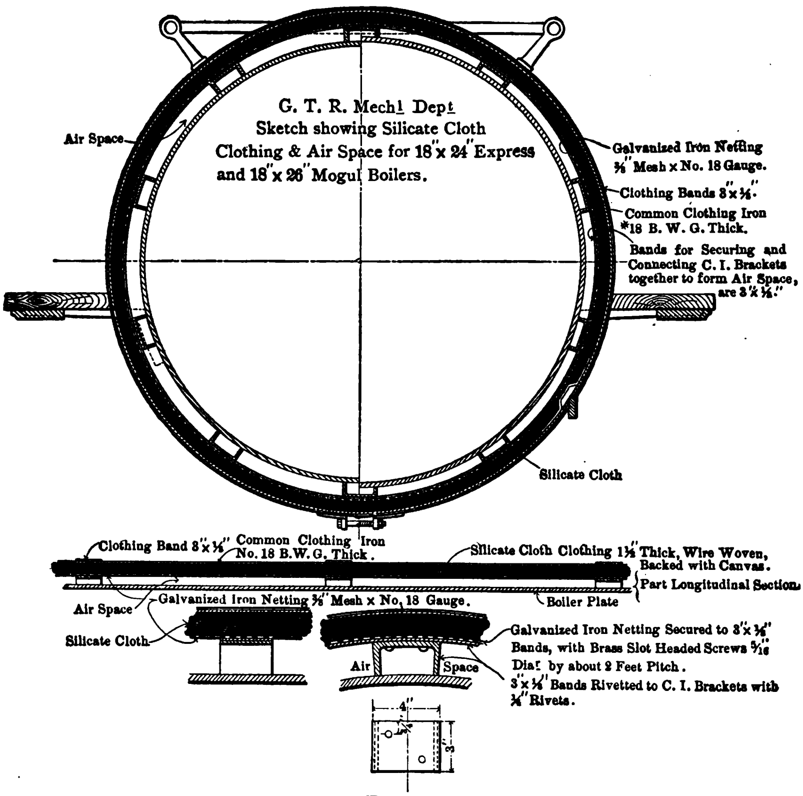


FIG. 1.

owing probably to the manner of conducting the experiments, but the several ratios are on the whole mutually confirmatory.'

"The boiler was afterwards clothed, first with three-quarters of an inch of asbestos cement securely held in place by a sort of "lathing" of wire cloth of $\frac{1}{2}$ inch mesh, and over the asbestos a

covering of hair felt, which, when slightly compressed by the outward casing of galvanized sheet iron, was also about ¾ inch thick, making the whole covering about 1.5 inches. Around the smoke-box the entire thickness was of asbestos cement. The covering was complete over fire-box casing, including the door end as well as around the barrel of the boiler, but did not extend over the steam jacket casing of the cylinder. There was also a space of six inches in height at the bottom of the fire-box, all around; it was left uncovered for convenience of access to hand holes, mud plugs and blow off cock.

"'The process of raising steam was not again noted, as it was thought to be impracticable to make a second fire which should be known to be sufficiently like the first one to admit of useful comparison; but loss of pressure by radiation was carefully noted, the time being taken as each successive pound was reached, as well as each 2.5 pounds, the steam gauge being graduated to pounds.'

"The time as given in the sixth column of the table, and the percentage of the saving, is worked out as before and is given in the seventh column. At the bottom of the fifth and seventh columns the mean of the percentages is given, from which it will be seen that the loss by radiation from a naked boiler is 11.8 per cent. And from a clothed boiler it is only 5 per cent., or less than half of the former.

"It must be kept in mind that the experiments were made on an engine which, while they were made, was stationary, and was protected from the weather by the building in which it was placed. The conditions were, therefore, much more favorable than they are on a locomotive engine, which, while at work, is always exposed to the wind, rain and cold air, and its motion produces currents by which whatever heat can escape is rapidly carried off. As a rule it is true that locomotive boilers and engines are better clothed than ordinary stationary and portable engines, but a very large portion of the boiler is very often left unclothed. It is seldom that the fire-box shell or casting is more than half covered. All attachments to it are so many means of communicating heat from the boiler to the surrounding air, and the lagging itself is not by any means the best non-conductor of

heat. The outside of the lagging of the cylinder part of a locomotive boiler is always so hot, with steam on, as to burn a person's hand if laid upon it. The cold air sweeping over this must carry away a great deal of heat, and notwithstanding the fact that the fire-box shell is partly covered by the cab, the loss of heat from this portion must be very much greater than that from a portable engine like that with which Mr. Hoadley made his experiments."

To your committee, an ideal covering is one that admits of ready application and removal; reduces radiation to a minimum; has durable qualities; is not injurious to metal plates, and is of sufficient stability for retention of symmetrical form of outside covering or jacket, for which Russia or Planished iron has been generally adopted, and, for the purpose, is unexcelled; being durable, readily manipulated, and having a surface that pleases the eye, and strictly in accordance with the teaching of philosophy that good reflectors of heat are poor radiators: thereby beauty and utility are combined and emphasize the wisdom in selecting such material for the purpose required.

Your committee conclude that it is inexpedient, at this time, to recommend a definite method and material for boiler covering, but recognize that there is a growing tendency for a more durable and effective material than wood, and urge that the economy in covering a portion of the boiler will be augmented by covering the remaining portion; which, as a rule, amounts to about 25 per cent. of the entire radiating surface.

G. W. STEVENS,
JOHN MACKENZIE, } Committee.
T. B. TWOMBLY,

DISCUSSION ON BOILER COVERING.

THE PRESIDENT—Gentlemen, you have heard the report of your Committee on Boiler Covering. What is your pleasure?

On motion of Mr. Sprague the report was received.

THE PRESIDENT—The subject is now before you for discussion.

MR. MACKENZIE—I am very sorry that Mr. Stevens is not here. He is the Chairman of the Committee and a gentleman who has given this boiler covering a great deal of attention for a number of years back. I think that he would relate to us some very good results that he has found in covering the entire boiler. I understand that he covers the boiler, the back sheet, the side

sheets, &c., clear to within three or four inches of the mud ring. I have never had any experience in that myself. I do not know just what the results are, but I think that there is a question that the members should talk about here, and that is, is it advisable to have an air-space between your covering and your shell, no matter what it may be? Another thing—is it advisable to leave it open at the bottom of the boiler? I think this all ought to come in this discussion here. I refer to leaving a space at the bottom of the boiler six, eight or ten inches wide, where the air can pass under the covering and around the boiler. I have seen that tried with results in my opinion that were not very satisfactory, and then I have heard people say that it was a benefit to the boiler. The argument that they made was, that there was more or less scale, rust and one thing or another that was coming from the boiler, and this open space allowed it to pass around and off, thereby keeping the sheets clean all the time. That is, if the boiler should be covered so long that it became rusty, which might occur from putting on green lumber, and standing your engine out of the round-house, this rust would accumulate there and by the action of the heat be thrown off and pass around and off instead of remaining in the boiler, as it would do if the space were not there. Those things I bring up for the purpose of having Mr. Swanston contradict them. (Laughter.) Mr. President, I would suggest that Mr. Graham, who is on the Lake Shore, where this system is used, can tell us something about it.

MR. GRAHAM—What do you want to know about it?

THE PRESIDENT—We want to know all there is about it.

MR. GRAHAM—I think this Committee has exhausted everything. So far as furnishing any figures is concerned I could not do so on so short notice. As to the mechanical application, we use felt, asphalt and held on with string until we get our hoops on; on the fire box we put felt and thimbles to hold the sheet out, and little studs to hold the sheet on. On the cylinder part of the boiler we put wood, but we put asphalt next to the boiler.

MR. MACKENZIE—Do you leave any air space at all?

MR. GRAHAM—No, sir; we cover everything we can reach. The boiler-head is covered with felt and the leg of the boiler—all around wherever we can get. As regards the economy of it I would like a little more notice before answering any questions.

MR. MACKENZIE—Mr. Graham has been on the road a number of years. I do not know whether he ever ran an engine or not with this covering on. But if he did, I would like to know how he kept from freezing in the winter time with this covering on. I understand it is so cold that a man has to carry a lamp in his pocket.

MR. GRAHAM—Our engineers made a fuss about them the first winter, but after the first summer they made no further complaint. It is not nearly so cold as you would think it would be. Our boiler head makes a pretty good radiator any way with a small cab. It is not so hot as it used to be, but it is warm enough. In the summer it is very much cooler than where no lagging is used.

MR. MACKENZIE—I heard some of the engineers make complaint that

they are very cold. I have not any doubt that there is benefit in covering those boiler heads.

MR. GRAHAM—I suppose you remember that when the air brake was applied they had a terrible time; and so with the injectors, it was a long time before they could make the injector supersede the pump. That is the way with this.

MR. LAUDER—If, as Mr. Mackenzie suggests, engineers are liable to be frozen in winter with the boiler head covered, it is certainly one of the strongest arguments to my mind that could be used in favor of covering the boiler. If the covering placed over the boiler head in the cab sufficiently protects the boiler from radiation of heat as to make it sensibly colder in the cab for the engineer than it was before the covering was put on, it is certainly an argument in favor of covering the boiler. There have been in years past a great many boiler coverings in the market for preventing the radiation of heat. A few years ago the Massachusetts Institute of Technology, through one of its professors, instituted a series of experiments to determine the relative value, or whether there was any value in these so-called non-conducting materials that are recommended for covering boilers; and their experiments, if I may use a little slang, "knocked the stuffing out of" about seven-eighths of these boiler coverings, among them asbestos, which is not a non-conductor. The heat will go through it as quickly as through iron. It is a non-conductor just to the extent that it is porous and filled with air. I think that statement is made in their report. The information gathered was very interesting. I think their conclusions were that about all the non-conducting qualities which any of these appliances possess, was in the amount of air spaces that they contained. Wood, for instance, is a good non-conductor. Take that wood and subject it to a hydraulic pressure, and lay it on a heated surface, and I think the heat would go through it very readily. Air is a very poor conductor. Asbestos is a non-conductor, if it is made up loosely with the air cells in it. If it is subjected to a high pressure and pressed together solidly, so that the air is thoroughly excluded, and there is no chance of there being any air space within it, I believe that they concluded that it was not a non-conductor. Felting is a non-conductor. Why? Because it is made up loosely and has a great many air cells. By the way, they make a point of it that the more subdivisions we could make in an air space, the better the non-conductor. They gave a reason for it which I have forgotten; but I think that one of their conclusions was that hair felting was a better non-conductor than the same amount of air space would be in one solid mass, because the air spaces were subdivided into a vast number of little cells. Now my practice has been in covering locomotive boilers to cover the boiler first with a thin sheet of asbestos. Not that I believe that it is a non-conductor farther than to the extent of keeping the wood from charring. The wood lining will last considerably longer than it would if it lay directly in contact with the plates. How it would compare in durability with wood secured away from the boiler a quarter or half an inch, I do not know; but I am inclined to think that it will last longer than it will if the wood is even

carried away so as not to come in contact with the plates. I find by that method that the wood lining lasts for a number of years, and gives a good, fair non-conducting material to cover a boiler with. It is cheap and simple in its application, and it will be, I think, quite a while before we can get anything that will supplant the wood packing, because it is simply a cheap and very good non conductor. My notion is that it would pay all of us to cover every exposed part of the boiler. It is perhaps expensive to cover the flat parts of the boiler and get a covering there that will stay, and not be giving trouble all the time, but I have not any doubt but that it would be well to do it. I have been recently covering the front of the boiler leg where the wind, of course, strikes it, and I think I can see a difference in the steaming qualities of the engine after those coverings are put on. I think covering the side plates, also the boiler head and cap, would prevent the loss of a great deal of the heat, and all the heat that is lost by radiation in that way is, of course, so much money represented in the coal bill.

MR. GEORGE GIBBS—I take Mr. Lauder's view of the subject of boiler covering exactly. The experiments, if I understand them, proved that the non-conducting value of a covering is due to its cellular character. Hair-felt is demonstrated to be one of the best non-conductors on account of its very spongy character, and the consequent large amount of air which it holds in stagnant suspension. An air space itself would be just as good, perhaps; but in an air space, as a whole, you can not keep the air from moving. In other words, you can not keep the air from leaving the boiler and cold, fresh air taking its place; in other words, you can not prevent the air carrying off the heat. In hair-felt, the air space being broken up into innumerable small cells, the air is held without moving. These boiler coverings, as far as my observation goes, are not so efficient as our old wood lagging. We have had only a short experience in that respect. But two engines we have recently received have been covered with a plaster covering formed by mixing with water and allowing it to dry, making a hard cover. These, as my observation goes, are much hotter than the old wood lagging. In fact, in investigating this engine I have been burnt several times against the shell of the boiler, and I never experience that difficulty with the old wood covering. I think we should provide for a good, tight air space around the shells.

MR. MACKENZIE—Do you use any air space between the plaster covering and the shell?

MR. GIBBS—No. It is simply pasted right on to the boller. As to the asbestos covering for covering steam pipes, I have found that the more spongy is its condition the better it is as a non-conductor. Some brands of covering come as plastic asbestos. These are not as good non-conductors as the felt asbestos. The lighter the felting is, the better it is. I do not look on Mr. Mackenzie's suggestion about cold cabs as a joke. In our country we could not think of covering the back of the boiler in winter. I have been almost frozen myself there.

MR. LYNE—It seemed, from the report, that the predominating covering

of boilers is pine wood. Why do we use it? Is it because it is the best thing to use, or because our grandfathers did it, and it has gone along till the present time with nothing of a better character to take its place? I believe that one of the most anxious moments of my life was when I was on a certain engine and a conflagration started inside the jacket. We found ourselves running along forty-five or fifty miles an hour with a red-hot jacket. I am convinced that wood is a very poor substance to put in contact with such a high temperature, though there are means at the present day of rendering it uninflammable. Hair-felt is an animal product, and is of course unsuited to those high temperatures, and after a time you will find that the hair-felt covering will be reduced to powder. Mr. Charles Emery, some years ago, tried some experiments when he was chief engineer of the New York Steam Heating Company, and he demonstrated that a confined air space was as good as any non-conductor that could be used on steam pipes. The smaller those spaces are made, the better; that is on account of reducing the circulation of air. If you can prevent the air from circulating, of course there is a great deal less radiation. Now, it seems to me that a good, practical test of the value of boiler covering is merely to put your hand on the boiler. If the heat does not come out it must be confined, that is certain. Now, I know lots of boilers that are covered with wood. The wood has shrunk and the air circulates there, and as a proof of that you will find that it is almost red hot in some places. The air does circulate there; it gets into the opening, and as the engine moves through the atmosphere that circulation is very rapid, and there is a great radiation and loss of heat. You take the best forms of asbestos cement, for instance; that is put on, first, by a coating of plaster of paris. That plaster of paris is put on to the boiler for the principal purpose of preventing corrosion. It is a good non-conductor, of course; but the boiler is not likely to corrode when it is coated by a whitewash. I say good asbestos cement, because there are cements in the market which, when put on a boiler, will crumble and break to pieces and come off. You put your hand on a boiler covered with that material and you will find that you can bear it there very comfortably, which is a practical proof that there is little or no radiation of heat from that boiler, and when a covering of that kind is put on your boiler it is durable; it will last for years. If a leak starts it is indicated right at the locality where it occurred, and you can cut out that portion of your cover, and after your rivet is plugged or bolt replaced, you can put the same material right back again. It seems to me that these forms of non-conductors indicate steps in advance, and in the current issue of the "North American Review" you will find an article by Prof. R. H. Thurston, of Sibley College, in which he takes this ground—that to reach a better economy in the application of the steam engine, we have got to look to a saving of the heat that is wasted and thrown away; and that is the aim of the best engineers of the present day —to study how they can save that heat which is lost.

MR. F. B. GRIFFITH—I have had a little experience with the asbestos covering. We have been putting it on to the cylinder part of our boilers for two years, and we did it partly to see if we could not save the wood lagging, and we

have been very successful with it. The engines are coming into the shops now for the first time for repair, and we find the lagging in all of them intact, with the exception of the hoops. The hoops are charred. Now, the way that we apply this asbestos is first to put on our hoops, and we run from an inch and a quarter hoop to three quarters, and then we start on the bottom and run up with our seven-eighths pine laggings, and as we run up we find it very convenient to stuff in this asbestos cement. It does not require any skill to do it, and as we get up on top we can apply it with our hands. We have no figures to show what saving has resulted and our method of testing the reduction of heat radiated has merely been the touch but we imagine that we meet with good results. The engines surely steam well and compare very favorably with those that we have not put that asbestos on. If there should be a leak anywhere that needs caulking in the seam, the asbestos is very easily removed, and it is only removed where it is moist, and you can put it back in the same place.

MR. O. STEWART—The Fitchburg road, I suppose, was one of the pioneers in the adoption of the asbestos covering for boilers. It was on very long before my time. To-day we have boilers that were covered sixteen years ago with asbestos. A coat of something—plaster of paris I presume—was put first on to the boiler, and then asbestos applied outside of that to the thickness desired; no wood of any kind was used, no hoops, no air space left between the covering and the boiler, and to-day I may say that that covering is as good as it was when it was put on. Now, if we go for economy in covering boilers I do not see anything that we have yet tried, that is so economical as the asbestos. That covering, if no accident occurs to the boiler, will be as good sixteen years hence as it is now, and wood lagging we know is good for about four years. After one year's service, the prevention of radiation is substantially gone. The wood has shrunk, it is charred, and it is substantially good for nothing as a protection to the boiler. The cost of the asbestos, of course, is much greater—the first cost—than the wood lagging. Wood lagging properly applied to a boiler would cost about twenty five dollars; for the same boiler the asbestos would cost about fifty-five dollars. When we take into consideration that the life of the asbestos is unlimited, that it is a thorough protection at all times to the boiler, that there is no fire, that there is no cracking of the asbestos, that there is no chance for the air to get to the boiler through it, that it is thoroughly protected at all times, I think that we have solved the problem of economy in covering boilers. So far as its being a non-conductor of heat, I have no figures to present. All I know is that these boilers that are covered retain the heat; boilers that are not covered radiate the heat. That we have demonstrated in our stationary room in a short time. We had a large boiler some twenty-five feet long, about eight inches in diameter and it was uncovered. It was a new boiler left uncovered until all the leaks should have been thoroughly stopped. It was almost impossible for a man to remain in the room. The boiler was covered with asbestos and it was a very comfortable sitting room after that.

MR. J. D. BARNETT, Grand Trunk—I infer from the discussion, as far as it has gone, that none of our members have had experience with the silicate

covering—silicate cloth as it is called. The silicate is a fibrous or semi-fibrous substance produced from the slag. That is its technical name in Staffordshire, England ; I do not know what it is called in America. It is obtained from the slag running from the blasting furnace in reducing iron ore. This silicate cloth has all the advantages of hair felt. That is, there are far more air spaces in it than are obtainable in the ordinary asbestos clothing. It is absolutely indestructible. Anybody familiar with the question knows that silicate is almost as indestructible as the diamond. I do not think it can be adulterated—a decided advantage over asbestos. If you get it at all you purchase the pure article. I was under the impression that one of our officers had written to the Committee on this subject, and therefore I did not come prepared with any figures on this matter, consequently I can not give them to you. But our mode of applying it, is to put rings of angle iron around the barrel of the boiler, the said angle iron being about an inch in depth. That gives us the air space. Around that we put a wire netting, and the silicate cloth is put over that. It can be sewed together with good steel wire or good copper wire, and the metallic or Russia sheeting is put outside of that. It enables us to take the whole sheeting off intact; and although I have to acknowledge that the first expense is heavier than that of any covering I am familiar with, it does its work exceptionally well. First, of course, having an inch air space, which is an absolute air space, the intention being not to have any communication with the atmosphere whatever, then outside the netting there is this thickness of silicate cloth—about one inch, which has a great many air cells in it, and it would require enormous pressure to pack that together. So, as I said before, it has all the advantages of a hair fibre ; the particles are well separated and each particle has a hold on its neighbor, so that it holds well together. As I say, in first cost it is expensive, but being practically indestructible and it being possible to remove the old coating and put it on again, it makes a coating that the Grand Trunk Railway is well satisfied with.

SECRETARY SINCLAIR—That matter which Mr. Barnett has referred to will be somewhat more fully explained when the report comes out. Illustrations, which have been engraved, have been sent in by Mr. Wallis and they will show the method of applying the silicate cloth to the boilers, and from the engravings it looks a strikingly simple and effective method. I think that a good many of our members are familiar with the material from which silicate cloth is made, under the name of mineral wool. It is the same substance that is known in this country as mineral wool. It is an admirable non-conductor and might be used for a great many purposes to prevent radiation about boilers and cylinders.

MR. HICKEY—I would like to inquire of Mr. Barnett what is the relative cost of applying a silicate covering compared with wood or asbestos or hair felt.

MR. BARNETT—I attempted to make it clear in our statement that, assuming that our people had sent all the information and comparative figures, I did not come prepared with the figures, and I can not therefore, give them to the Convention. I am sorry it is so, but I did not expect to have to mention a word on the subject.

MR. CHARLES BLACKWELL—For the benefit of those who are thinking of trying asbestos as a boiler covering, I would suggest that before they purchase a lot of asbestos they have it examined chemically. I know that asbestos as sold varies considerably in quality. With one lot you could cover your boiler and it will give excellent results, whereas, another lot will eat out your jacket in a year.

MR. MACKENZIE—The question of air space does not seem to be very well settled here. I would like to ask Mr. Stewart what the wear of the jacket over his covering is as compared with the wooden lagging. That is one of the questions. Another thing—if the covering has not been removed during these sixteen years from the boiler, what condition the boiler is in?

MR. STEWART—I would state in answer to that question, that for the six years that I have been on the Fitchburg road, that covering has not been removed; also, that it has the same jacket on that was put on sixteen years ago.

MR. MACKENZIE—That must have been the genuine Russia.

MR. HICKEY—I move that the discussion on boiler covering be now closed.

The motion was carried.

THE PRESIDENT—The next business in order is the report of the Committee on "Driver Brakes; best manner of applying, including best form and material for driving Brake Shoes." The report is in the hands of the Secretary. Mr. Blackwell, Chairman of the Committee, will read the report.

Mr. Blackwell read the report, which is as follows:

REPORT OF COMMITTEE ON DRIVER-BRAKES.

Your committee on driver-brakes find that the use of this device has within the past two or three years increased in a very marked degree, evidently accompanying the recent increment in weight and speed of both passenger and freight trains.

The still more general use of the driver-brake appears probable and will, doubtless, result in the safer operating of our railroads.

The Westinghouse Company report that up to the present time, they have furnished about 7,500 sets of driver-brakes of their type (Fig. 2), and that the American Brake Company has supplied about 3,800 sets of their style of brake (Fig. 3). The Eames Vacuum Brake Company state that their driver-brake (Fig. 4) is in use on 364 different railways, but do not give the number of sets. The Beals Railway Brake Company advise that 55 sets of their device (Fig. 5) have been applied to engines on six different railroads.

Reference to the accompanying table, "Appendix A," shows

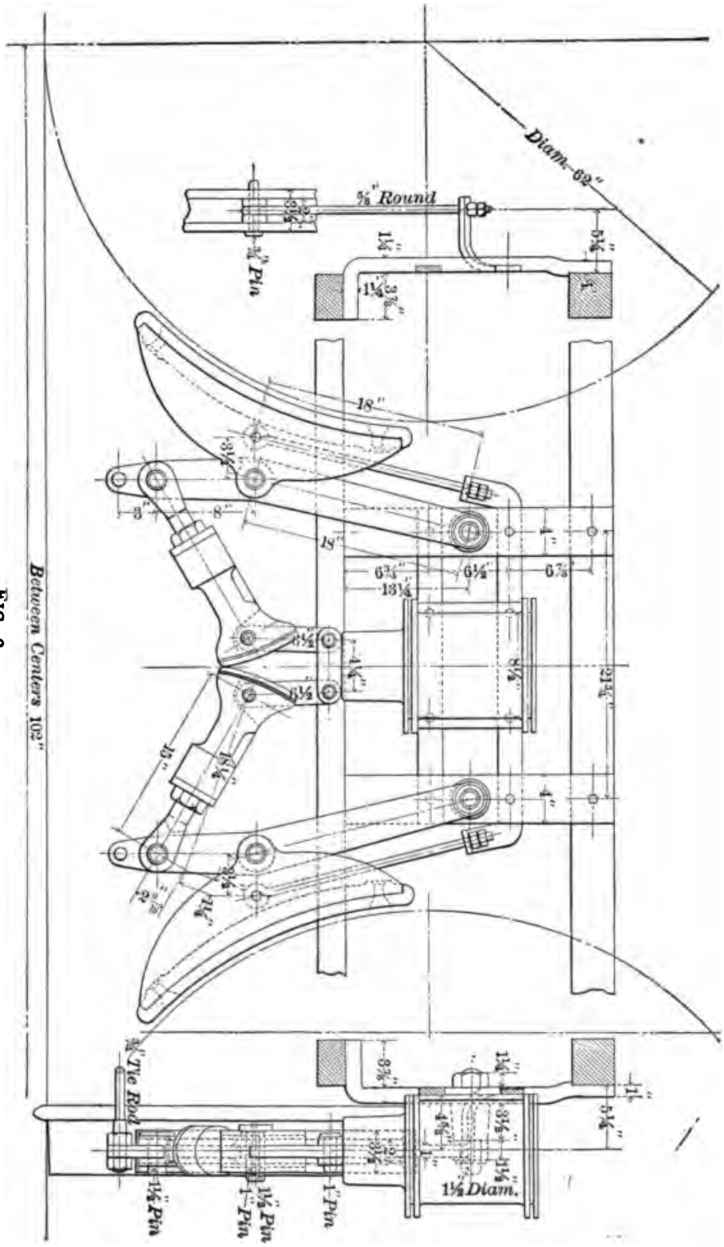


FIG. 2.

that compressed air, steam and vacuum are all undergoing extended trial as motive power for the operation of the brakes. Each has its votaries, who, under the various conditions of traffic, speed, grades and climate, uphold its relative advantages.

Some master mechanics consider it better, in view of possible failure of the power operating the train brake, and which, on account of its most general adoption, may be considered compressed air, to use either steam or vacuum for applying the driver-brake. This should be arranged without an additional handle for engineer, for as your committee are of opinion that the driver-brake should, as a rule, be used in conjunction with train brake, on both passenger and freight engines, the additional handle would cause confusion.

The following statement received from the C. B. & Q. railroad and showing the marked improvement made in the arresting power of driver-brakes on that railroad, illustrates what can be done by intelligent investigation, and improvements in details thereby indicated. The results of the Westinghouse brake in 1886 were obtained with the "spread" style of brake, while those in 1887 were with the "clasp" brake, which style your committee recommend in all cases where its application is possible.

"Best stops with driver-brakes at Burlington, brake-tests, 1886, 1887, 8 wheeled passenger engines, 54,000 lbs. on drivers, weight of engine, tender and way-car, 168,000 lbs., 63 per cent. of this braked:

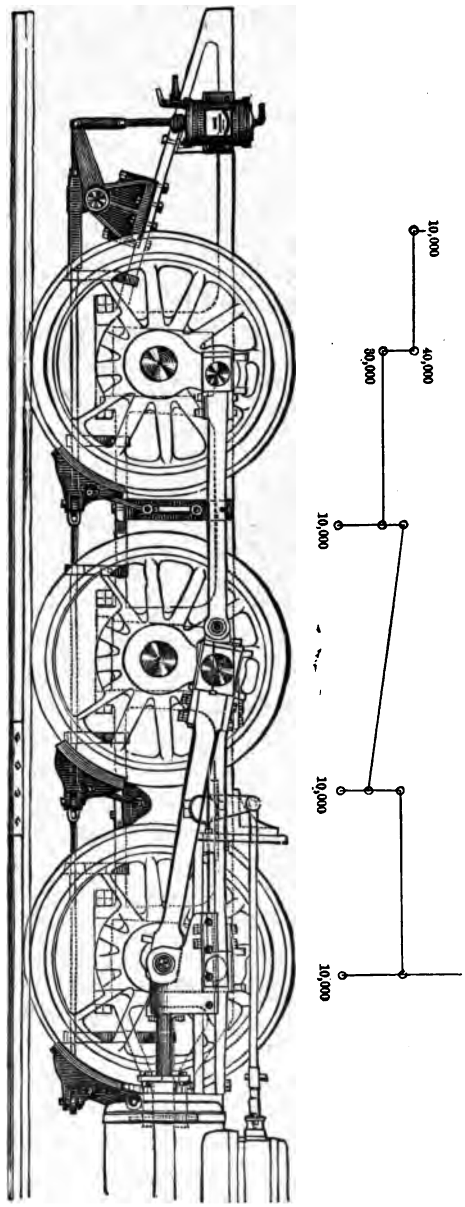
	1886.		1887.	
	Stops in feet on level.			
	20 m. p. h.	40 m. p. h.	20 m. p. h.	40 m. p. h.
American (steam)	203	833	---	---
Westinghouse	352	1457	194	914
Eames	272	1002	279	1058
Carpenter	---	----	167	692

showing improvement in the case of the Westinghouse brake between 1886 and 1887 of 45 per cent.

Consolidation engine, with pull-brake, and shoes on all drivers, on level:

	1887.	
	Stops in feet.	
	20 m. p. h.	40 m. p. h.
American (steam)	330	763
C. B. & Q. (air)	254	904"

When driver-brakes are used for making all stops, each wheel



Standard Outside Equalized Pressure Brake, for two or more pairs of Drivers, furnished to operate with either STEAM or AIR.

FIG. 3.

should be braked, or unequal wear of tires and consequent difference in diameter will result, especially where the ordinary narrow shoe is employed; hence your committee advise the application of brakes to each driving wheel.

Experiments are now being extensively tried in order to determine the best material, or combination of materials, and also the best form, for driver-brake-shoes.

Your committee unhesitatingly recommend the principle of the Ross shoe, but are not prepared to state conclusively, until more exhaustive trials have been made, if the cast steel, the Meehan, the Lappin or the Congdon make of the Ross shoe will, all things considered, give the best results. Some shoes, while possessing great endurance, are charged with excessive wear of the tires.

This feature may be overcome by modification in the composition and treatment of the metals and in making the shoes, but probably at their expense.

The excellent tire-dressing results obtained by using the "Ross-Meehan" and the "Ross Steel" shoes, and as shown on blue prints and tabular statements accompanying this paper are worthy of attention.

Your committee regret that they have been unable to obtain information which would enable them to illustrate the comparative wear, under similar conditions, of the various makes of brake-shoes above referred to, and of the tires to which they were applied.

Neither have they been able to produce figures giving the measure of braking power possessed, under similar conditions, by shoes made of various materials.

In some cases the "Ross steel" and the "Ross Meehan" shoes are reported as out-wearing eight to ten ordinary cast-iron shoes of similar pattern; and in other cases as increasing the mileage of tires, between the turnings, from 200 to 500 per cent., as compared with the old style of shoe, bearing on the tread of wheel only.

The P. W. & B. R. R., on this point, report as follows:

"The greatest improvement we have ever had in the way of driver-brakes, is the Ross Steel Shoe. Since we have commenced to use this kind of shoe, we can get from two to as

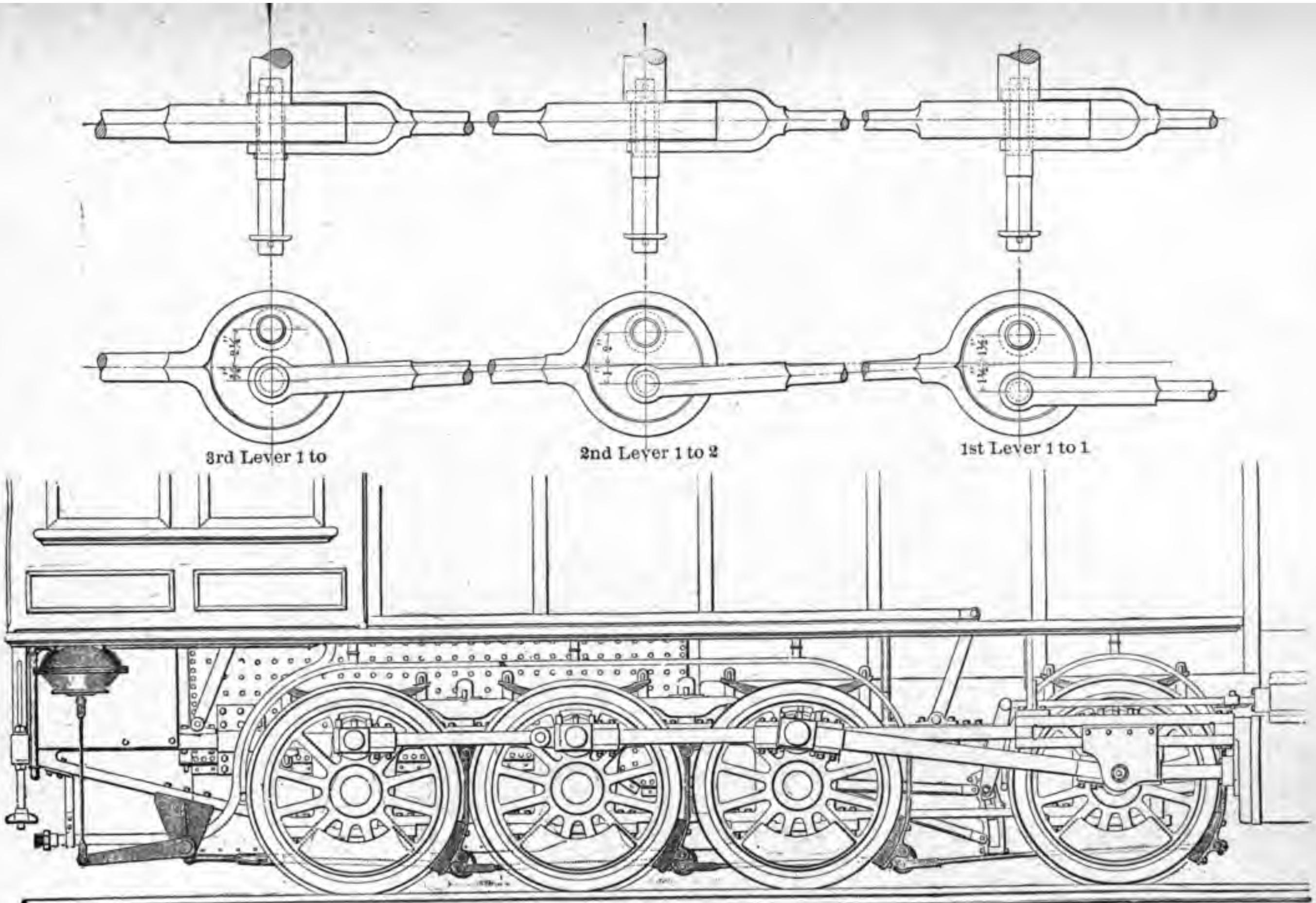


FIG. 4.

many as five times more mileage from our tires between turnings, thus saving the cost of the latter, as well as the loss of service of engines while work is being done. It has completely removed the annoyance of being compelled to remove from service engines that are in good condition, excepting that the tires must be turned. Formerly, in nine cases out of ten, it was the bad condition of tires that shopped an engine. Now it is not uncommon to shop an engine for quite extensive repairs, and not turn tires at all."

These advantages are obvious, and when more generally understood will tend to break down prejudice against the use of driver-brakes, and consequently to increase the proportion of engines so equipped.

A tabular statement, "Appendix B." supplied by the P. W. & B. R. R., and showing mileage made between turnings and per 1-32 inch of wear of tires, in the case of seven different engines, fully illustrates the advantage of using the "Ross Steel" shoe as compared with wrought iron shoes of the ordinary narrow pattern.

Your committee feel compelled to point out the unfortunate existence of an excessive number of different patterns of brake heads and shoes now in general use. Where clearance between wheels is limited, special forms of heads and shoes are necessary, but these special patterns, as well as those used where plenty of room exists, should be reduced to a minimum, and care taken to make those of a kind thorougly interchangeable, which, it is to be regretted, is not always done.

Improvements in the proper equalization of the brakes are coming to the front, and appreciated by those fortunate enough to secure them. Some are illustrated by blue-prints herewith.

As regards the most desirable ratio between brake-shoe, pressure, and weight on rail, your committee recommend for the Ross pattern of shoe, and clasp-brake, from 30 to 35 per cent.

The pressure per square inch sustained by brake-shoes varies in different designs that have come to the notice of your committee, from 50 to nearly 200 pounds. Until more is known on this point, they refrain from recommending limits within which best results may be expected.

The Le Chatelier, or water-brake, is practically a driver-brake,

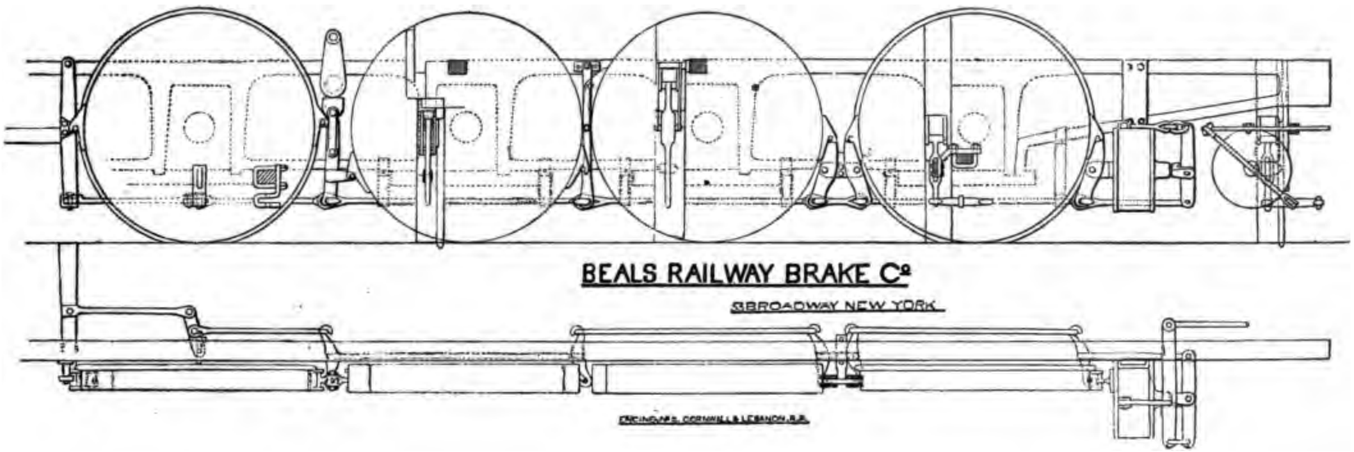


FIG 5.

and as a device for holding engines on heavy grades, appears to be too little known.

Mr. N. W. Sample, Superintendent M. P., of the D. & R. G. R. R. reports as regards this brake:

"We never pretended to use it for the purpose of retarding trains, as we have had all our cars and engine-tenders equipped with air brakes since 1877. For the purpose of holding light engines on heavy grades, where the tank brake is not sufficient, there is certainly nothing so good as Le Chatelier's device. We use it

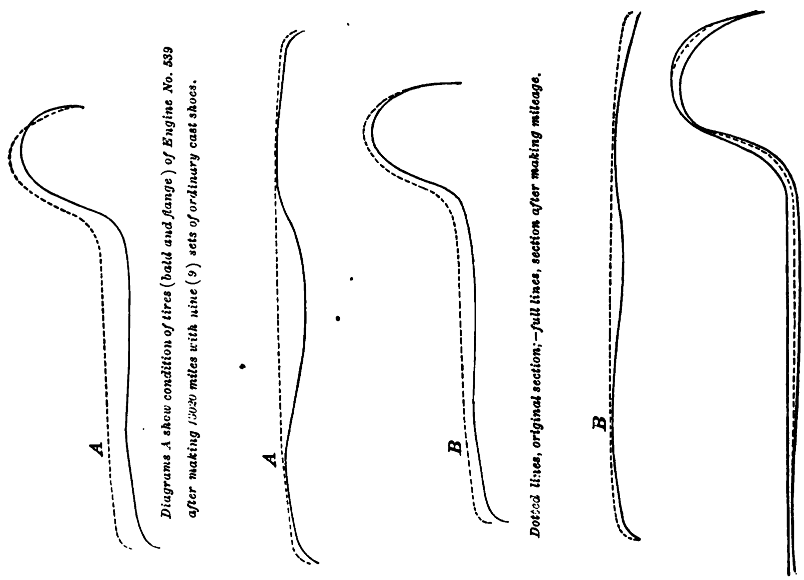


FIG. 6.

on our locomotives daily on grades from 100 to 408 feet per mile. We have no driver-brake shoes. We discarded all brakes that apply directly to the face of the driving wheels, eight years ago. In my opinion, the very best driving brake is Le Chatelier's device."

The following communication was received from Messrs. Rhodes and Forsyth of the C. B. & Q. R. R.:

"There is a great difference in the efficiency of driver-brakes,

not only between different systems, but on different engines with the same system, depending largely upon the manner in which the brakes are fitted up.

"The Master Mechanics' Association could establish a standard of excellence, expressed in the number of feet on a level, in which an engine (with tank loaded to weigh an even 50,000 pounds) could stop itself at speeds of say 20, 40 and 60 miles per hour.

"Any master mechanic could easily make a list of the driver-

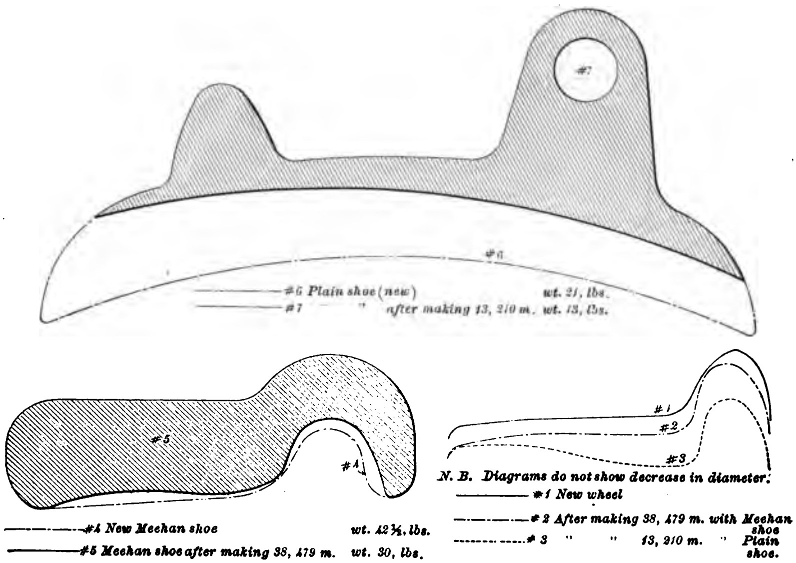


FIG. 7.

brakes of his engines, and by comparing the results with figures presented by the Association as showing a high efficiency, he could tell at once how good or how bad his driver brakes were working, and thus having a measure of their efficiency, would better appreciate the necessary improvement. We regard this as the most valuable work the Master Mechanics' Association could do on the subject of driver-brakes."

This letter came to hand at too late a date to enable your committee to take any action in the direction named, but it is to

be hoped that within the next 12 months some of the members will be induced to experiment with a view of obtaining data that will be useful in establishing standards of efficiency, as suggested by Messrs. Rhodes and Forsyth.

Respectfully submitted by

CHARLES BLACKWELL,
H. D. GORDON,
W. H. THOMAS,
Committee.

APPENDIX "A."

STATEMENT ACCOMPANYING REPORT ON DRIVER-BRAKES.

NAME OF RAILROAD.	No. of engines equipped with driver-brakes.				No. of engines with brake operated by			No. of engines with			Remarks.
	Pass.	Freight	Switch.	Total.	Air.	St'am	Vac'um	Spread type.	Pull type.	Clasp type.	Brake to be used:
C. & E. I.	8	31	10	49	8	41	0	30	19	0	For emergencies only.
C. & O.	38	89	4	131	95	36	0	103	28	0	For all stops.
C. & W. Ind.	0	5	20	25	12	7	6	5	20	0	" "
C., B. & Q.	90	287	92	469	469	0	0	385	84	0	" "
Cent. Vermont	3	10	3	16	0	1	15	0	16	0	For emergencies only.
C., R. I. & P.	105	181	75	361	1	1	359	311	50	0	" " "
C., St. P., M. & O.	26	74	18	118	103	14	1	111	6	1	For special cases only.
Fall Brook C. Co.	1	45	2	48	4	40	4	15	31	2	For all passenger stops and emergencies on freight.
Fitchburg	4	52	28	84	11	0	73	4	80	0	For all stops.
K. C., F. S. & M.	16	87	27	130	12	100	18	84	46	0	" "
L. S. & M. S.	90	253	123	466	90	376	0	456	10	0	" "
P., W. & B.	124	22	33	179	179	0	0	179	0	0	" "
Wabash	39	80	20	139	92	47	0	136	3	0	For emergencies and special cases.
E., T., V. & Ga.	10	39	9	58	30	15	13	----	---	---	For all stops.
Totals	554	1,255	464	2,273	1,106	678	489	1,819	393	3	

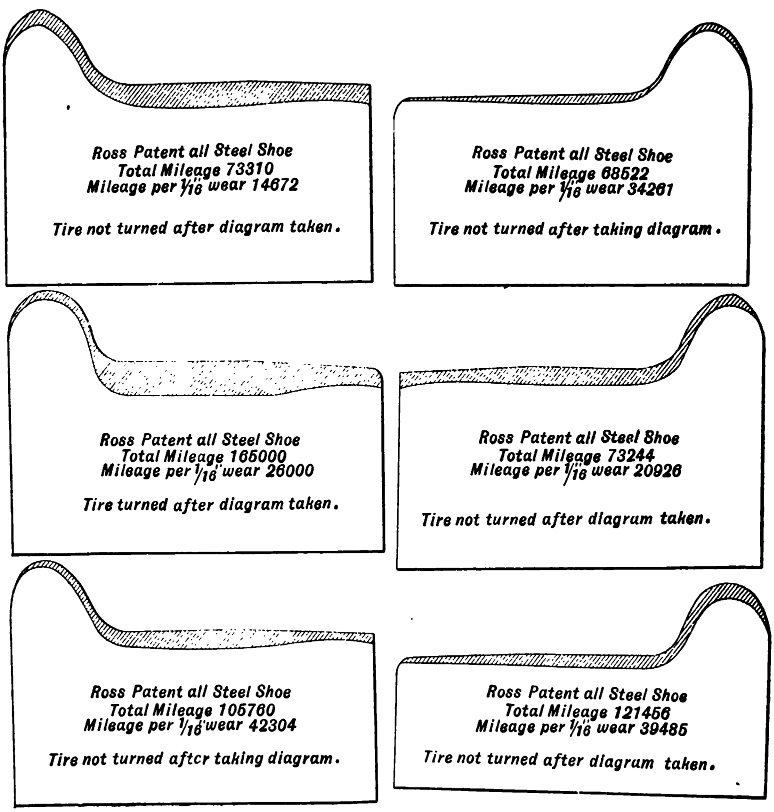

Ross Patent all Steel Shoe
Total Mileage 73310
Mileage per 1/16" wear 14672
Tire not turned after diagram taken.
Ross Patent all Steel Shoe
Total Mileage 68522
Mileage per 1/16" wear 34261
Tire not turned after taking diagram.
Ross Patent all Steel Shoe
Total Mileage 165000
Mileage per 1/16" wear 26000
Tire turned after diagram taken.
Ross Patent all Steel Shoe
Total Mileage 73244
Mileage per 1/16" wear 20926
Tire not turned after diagram taken.
Ross Patent all Steel Shoe
Total Mileage 105760
Mileage per 1/16" wear 42304
Tire not turned after taking diagram.
Ross Patent all Steel Shoe
Total Mileage 121456
Mileage per 1/16" wear 39485
Tire not turned after diagram taken.

Fig. 8.

APPENDIX "B,"

ACCOMPANYING REPORT ON DRIVER BRAKES.

ROSS STEEL SHOES VS. PLAIN WROUGHT IRON SHOES.

COMPARATIVE MILEAGE OF TIRES BETWEEN TURNINGS AND PER $\frac{1}{32}$ INCH OF WEAR.

ENGINE NO. 204, BUILT BY P., W.& B.R.R.CO. 62 IN. WHEELS; 16 x 24 IN. CYLS.; WT. ON DRIVERS, 44,400 LBS.

DATE OF TURNING.	Thickness after turning.	Mileage between turnings.	Time between turnings.	Mileage per $\frac{1}{32}$ in. wear.	Remarks.
May 21, 1884 (new)	3 in.				
Dec. 3, 1885	$2\frac{10}{32}$ in.	30782	18 mos.	1399	Plain Wrought Shoes.
Dec. 27, 1887	$1\frac{24}{32}$ in.	35101	25 mos.	3061	Ross Steel Shoes. Applied June, 1886.
May 1, 1889	$1\frac{15}{32}$ in.	32966	17 mos.	3663	Ross Steel Shoes. Tires still in service and in good condition.

Service—Local Passenger.

ENGINE NO. 77, BUILT BY BALDWIN LOCO. WORKS. 68 IN. WHEELS; 17 x 24 IN. CYLS.; WT. ON DRIVERS, 50,400 LBS.

DATE OF TURNING.	Thickness after turning.	Mileage between turnings.	Time between turnings.	Mileage per $\frac{1}{32}$ in. wear.	Remarks.
July 31, 1882 (new)	$3\frac{2}{32}$ in.				
June 18, 1883	$2\frac{28}{32}$ in.	26135	$11\frac{1}{2}$ mos.	4356	Plain Wrought Shoes.
Dec. 12, 1884	$2\frac{12}{32}$ in.	72436	18 mos.	4527	" " "
April 18, 1886	$1\frac{26}{32}$ in.	72323	16 mos.	4018	" " "
April 1, 1889	$1\frac{10}{32}$ in.	119628	37 mos.	7477	Ross Steel Shoes. Applied December, 1886. Engine shopped for general repairs April, 1889. Tires in good condition, but too thin for further service.

Service—Through and local Passenger and Freight.

APPENDIX "B."—CONTINUED.

ENGINE NO. 218, BUILT BY BALDWIN LOCO. WORKS. 62 IN. WHEELS; 16 x 24 IN. CYLS.; WT. ON DRIVERS, 41,900 LBS.

DATE OF TURNING.	Thickness after turning.	Mileage between turnings.	Time between turnings.	Mileage per $\frac{1}{32}$ in. wear.	Remarks.
Feb. 13, 1885 (new)	3 in.				
June 30, 1886	$2\frac{6}{32}$ in.	47728	$16\frac{1}{2}$ mos.	1836	Plain Wrought Shoes.
April 1, 1889	$1\frac{29}{32}$ in.	96987	30 mos.	10776	Ross Steel Shoes used. Tires will true up to thickness given and are still running in good condition.
Service—Local Passenger, with frequent stops. Road hilly and crooked.					

ENGINE NO. 85, P.R.R. STANDARD, CLASS "O." 62 IN. WHEELS; 18 x 24 IN. CYLS.; WT. ON DRIVERS, 58,300 LBS.

DATE OF TURNING.	Thickness after turning.	Mileage between turnings.	Time between turnings.	Mileage per $\frac{1}{32}$ in. wear.	Remarks.
July 1, 1884 (new)	3 in.				
June 6, 1885	$2\frac{14}{32}$ in.	24794	11 mos.	1377	Plain Wrought Shoes.
Feb. 18, 1886	$1\frac{28}{32}$ in.	28849	$8\frac{1}{2}$ mos.	1603	" " "
Nov. 26, 1887 (removed)	$1\frac{14}{32}$ in.	58942	21 mos.	4210	Ross Steel Shoes.
Nov. 26, 1887 (new)	3 in.				" " "
May 20, 1889	$2\frac{18}{32}$ in.	55902	18 mos.	3993	" " " Tires in good condition, but engine shopped for general repairs.
Service—Local Passenger and Freight.					

APPENDIX "B."—CONTINUED.

ENGINE NO. 208, BUILT BY BALDWIN LOCO. WORKS. 62 IN. WHEELS; 17 x 24 IN. CYLS.; WT ON DRIVERS, 52,000 LBS.

DATE OF TURNING.	Thickness after turning.	Mileage between turnings.	Time between turnings.	Mileage per $\frac{1}{32}$ in. wear.	Remarks.
June 9, 1884 (new)	$3\frac{2}{32}$ in.				
Feb. 13, 1885	$2\frac{8}{32}$ in.	20934	8 mos.	805	Plain Wrought Shoes.
April 17, 1886	$1\frac{26}{32}$ in.	39710	14 mos.	2836	" " "
Jan. 10, 1889 (removed)8	$1\frac{4}{32}$ in.	88723	33 mos.	4033	Ross Steel Shoes. Applied in June, 1886.

Service—Local Passenger and Freight.

ENGINE NO. 216, BUILT BY BALDWIN LOCO. WORKS. 62 IN. WHEELS; 17 x 24 IN. CYLS.; WT. ON DRIVERS, 52,000 LBS.

DATE OF TURNING.	Thickness after turning.	Mileage between turnings.	Time between turnings.	Mileage per $\frac{1}{32}$ in. wear.	Remarks.
June 30, 1884 (new)	3 in.				
Feb. 26, 1885	$2\frac{8}{32}$ in.	13252	8 mos.	552	Plain Wrought Shoes.
April 23, 1886 (worn out and removed	$1\frac{14}{32}$ in.	40962	14 mos.	1575.5	" " "
April 23, 1886 (new)	3 in.				Ross Steel Shoes. Applied June, 1886. Engine still in service April 1, 1889, and tires in good condition.
April 1, 1889	$2\frac{24}{32}$ in.	123295	35 mos.	15412	

Service—Local Passenger. Road very hilly and crooked.

APPENDIX "B."—CONTINUED.

ENGINE NO. 88, P.R.R. STANDARD, CLASS "C." 62 IN. WHEELS; 17 x 24 IN. CYLS.; WT. ON DRIVERS, 51,200 LBS.

DATE OF TURNING.	Thickness after turning.	Mileage between turnings.	Time between turnings.	Mileage per $\frac{1}{32}$ in. wear.	Remarks.
Jan. 30, 1884 (new)	$3\frac{6}{32}$ in.				
Dec. 20, 1884	$2\frac{18}{32}$ in.	27919	11 mos.	1269	Plain Wrought Shoes.
Aug. 29, 1885	$2\frac{2}{32}$ in.	22671	$8\frac{1}{2}$ mos	1619	" " "
May 3, 1886	$1\frac{16}{32}$ in.	21868	8 mos.	1215	" " "
March 10, 1887 (removed)	$1\frac{7}{32}$ in.	28404	11 mos.	3156	Ross Steel Shoes. Put on July, 1886.
March 10, 1887 (new)	3 in.				
March 18, 1889	$2\frac{10}{32}$ in.	58552	24 mos.	2661	Ross Steel Shoes.

Service—Local Passenger and Freight.

APPENDIX C.

Figure 6 illustrates the relative wearing life of ordinary cast-iron shoes and of Ross Meehan shoes on the Central Railroad of Georgia.

	KIND OF SHOES.	
	Ross Meehan.	Cast Iron Shoes.
Weight of shoes, new ....lbs.	260	9 x 229 = 2061
" " " when removed...... "	166	9 x 125 = 1125
" " metal lost .... "	94	9 x 104 = 936
Metal lost per 1,000 miles ... . "	7.2	71.9

Assuming total metal lost when worn out, to be the same in the case of the Meehan, as in each set of plain cast-iron shoes,

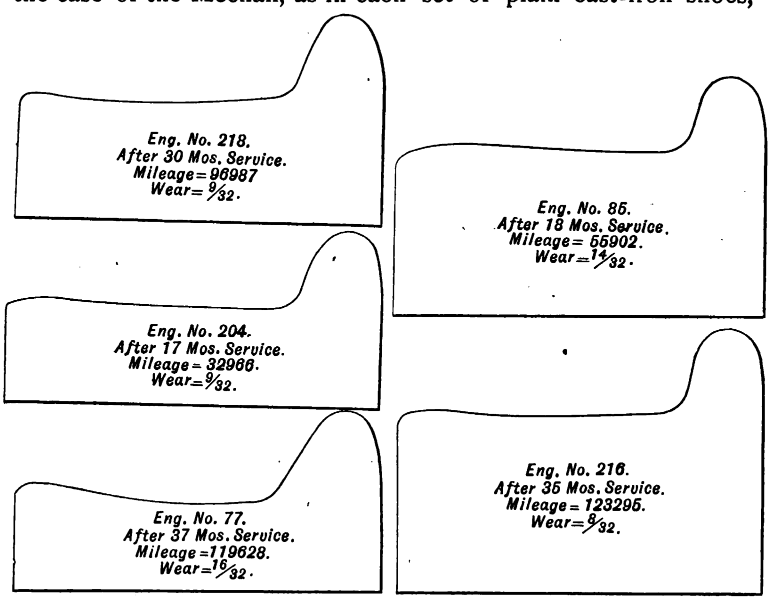


FIG. 9.

viz, 104 lbs., the total life of the Meehan shoes—14,405 miles, which would represent a total loss by wear of cast-iron shoes, of 1,035 lbs., or a difference of 931 lbs.

Diagrams B. B. show condition of tires bald and flange on engine No. 538 after making 13,020 miles equipped with one set of Ross Meehan shoes; weight of Ross Meehan bald shoe when applied, 52 pounds; flange 39 pounds. Weight at observation—bald 32 pounds, flange 25½ pounds. Weight of ordinary cast shoe when applied—bald 36½ pounds, flange 39 pounds. Weight of each of the nine shoes when removed—bald 19½ pounds, flange 21½ pounds.

The diagrams on Fig. 7 illustrate the relative wear of ordinary cast-iron shoe, and of Meehan shoes on a Mann Boudoir Car and reported on by W. B. Pettitt, Superintendent.

The diagrams shown in figures 8 and 9 illustrate the wear of tires where the Ross All Steel Shoe was used.

DISCUSSION OF REPORT ON DRIVER BRAKES.

On motion the report was received.

THE PRESIDENT—The report is now before you for discussion.

MR. CHARLES BLACKWELL—I may say that since the report was printed, several letters and blue prints have been received by the committee. These blue prints, together with those previously received, are now exhibited on the walls of the room. Attention is directed to the latest form of equalized brake as designed and manufactured by the Eames Vacuum Brake Company (Fig. 4), and possessing the merit of a minimum number of parts. The latest practice of the Westinghouse Air Brake Company, of the spread type, is plainly shown by blue print (Fig. 2) furnished by that company. The Beals Brake (Fig. 5) as designed for engines with six and eight driving wheels, the latter case having wheels placed very close together, is also illustrated by large scale blue prints. This latter company states that fifty-five sets of these brakes are now in successful operation. Tabular statements showing the relative wear of the Ross-Meehan brake shoe, as compared with shoes of ordinary cast iron, are amongst the papers received too late to be referred to in the report just made. They deserve special mention. It is much to be regretted, however, that the actual wear of tire during these experiments is not shown on any of the prints. This is a factor that must be taken into account in comparing results, and it is hoped will be forthcoming, when the subject of driver brakes is next brought before the Association.

MR. MACKENZIE—I move that the papers, etc., referred to by Mr. Blackwell, be embodied in the report.

The motion was seconded.

MR. LAUDER—Before that motion is put, I would suggest that it be amended so as to leave it to the committee of which Mr. Blackwell is chairman, to in-

corporate such portions of those communications as the committee see fit, and I would move an amendment that it be left with the committee.

MR. MACKENZIE—I accept the amendment.

The motion as amended was carried.

THE PRESIDENT—We ought to have a discussion upon this subject, gentlemen. In passing around the country I hear some complaints about the driver brake. Now is the time to talk about it.

MR. J. C. RAMSAY—Just to get the discussion started I would say that I am using driver brakes, and that I have found better satisfaction with the Eames brake than anything else I have used. This is more particularly the case with regard to steam pipes and packing.

MR. T. W. GENTRY—I would like to find out from some of the gentlemen present who use driver brakes of the American type, whether they have any trouble in keeping the brake suspended perpendicularly—whether it has a tendency to come out at the top, or work out at the bottom. We have not succeeded in preventing them from springing out at the bottom, and cutting away the flange. . That is more particularly the case with consolidation engines.

MR. GEORGE GIBBS—We have had trouble on ten wheel engines. I would say that in one of the sets they have sent us now, that difficulty is remedied by using a parallel motion. It is working very well.

MR. W. H. THOMAS—East Tennessee, Virginia and Georgia. We have not experienced any trouble since we have ordered our floating lever system. We had considerable trouble with the system furnished us by the Westinghouse Company. Mr. Gentry knows all about it. The different systems we are using now, are giving us perfect satisfaction.

MR. Z. J. FERGUSON—Mobile and Ohio. We have got the outside American brake on a great many of our consolidation engines, also on our ten wheelers, and some on our moguls. They give us the same trouble that Mr. Gentry spoke of. We used the Ball tire shoe, and ran a parallel rod from one to the other to hold them, which obviates all the trouble from the brake shoes turning one way or the other. Since then we have had very good results with them.

MR. J. N. LAUDER—There is one feature of the question bearing on tires of driving wheels, that probably would have been discussed when the committee report on tires and tire wear was up, if that report had not been so summarily disposed of. It would have come out, probably, in the discussion on tires, that it would be very much more economical to pay higher prices than we now pay, if we could get a correspondingly better tire, for the reason that engines go to the shops for repairs, usually at the present time, because their tires need turning. That thing is growing in this way, our weights are increasing, and the tires wear correspondingly faster. Consequently our engines have to come into the shop for repairs, more rapidly than they have heretofore. Now, any appliance that will keep our tires from needing to be turned, we will probably all recognize as an improvement. The main argument that I should use in favor of the Ross-Meehan shoe would be, that that shoe, applied to the driving

wheel of the locomotive, will keep the flange, and the outside part of the tire, where it does not come in contact with the rail, down to near the wear in the middle of the tire that is caused by the abrasion of the rail; and consequently I believe that on passenger engines, with the Ross-Meehan shoe applied to the driving wheels, and the driving wheel brakes used to make all the stops, you can get at least twice the number of miles wear out of tires between turnings, that you can if you do not use a driver brake, or if you use the plain shoe in connection with the driver brake. So, while it does not perhaps lengthen the total life of the tire, it does prevent the necessity of turning the tires so often. I suppose it will be claimed, perhaps, by advocates of that shoe, that it actually increases the total life of the tire, over a tire where you use a plain shoe simply bearing on the tread. I presume that claim could be made good to a certain extent, because, with the Ross shoe it is cut out, and never comes in contact with the tire where the rail comes in contact with it; therefore producing no extra wear of the tire above what the rail produces; while with the ordinary plain shoe just coming in contact with the tread of the tire, it soon conforms itself to the contour of the tire, and then it abrades the tire where the rail wear comes, and consequently wears it away, probably faster than the Ross shoe does. That is where indirect saving comes in in the use of the Ross shoe. If it will keep your engine out two or three months longer, by reason of using that shoe, it is well worth the money which it costs, in excess of the common cast iron shoe.

MR. CHARLES BLACKWELL—I think that point is covered by the report. I think it is shown by the report just read, that by the use of the Ross shoe of a certain make, the mileage of tires is increased over and above the mileage which is given, when the ordinary shoe is used, of from 200 to 500 per cent.

MR. R. H. BRIGGS—I believe that so far as the relative merits of driving brake shoes are concerned, any one who has had experience with the Ross shoe, requires no more evidence of its efficiency. But my curiosity is excited just now about the relative merits of the way of applying a driver brake. I presume that some of our members may have had the same experience that I have had. We have on some engines a spread-brake. I noticed a short time ago, that one of our side rods had the main pin break. A short time after that, on the same engine, we broke a driving box, and a very short time after that another engine of the same class broke a driving box. Now, I attributed this breaking of the rod to weakness, but I have been thinking the matter over, and it occurred to me that the engineer let that wedge drop down a little on the back box, and he put his brake on, and stretched the distance a little too far, and the rod parted right in the eye. Now the question with me is this: Is it advisable to put on a brake of that kind where such accidents are likely to happen, and further, has any one else here had the same experience I have had in the matter? If so, we ought to study the matter up, and try to overcome just such difficulties.

MR. Z. J. FERGUSON—For the information of Mr. Briggs, I would say that I had an experience of the same kind three months ago. In an engine with a cam brake between the drivers, a Westinghouse air brake, the rod started right

in the middle, and I attributed it to a weak spot right through the middle of the eye. I repaired it and in about three or four days after that, another engine of the same kind, fitted up with the same kind of brake, broke the rod right back of the eye, but, I just attributed it to weakness of the rod—a faulty rod, or something of that sort. Since you spoke of it I think that your explanation is very plausible.

MR. E. M. ROBERTS—Ashland Coal and Iron Company.—I notice that the Committee recommend the application of the driver brake at all times for the ordinary stops of trains. Now, it seems to me that we are getting a good deal of unnecessary wear on our tires in a good many cases, which we could save by having a separate engineer's valve for operating the driver brakes. Of course there are trains perhaps where it would be better to have them in conjunction, where the time is fast, and as little delay as possible is desired at stations; but when we apply those to all of our engines every time we stop, we are grinding our tires, and we are racking our engines unnecessarily. Now, who ever saw an engineer that did not like to have some little reserve there in case of an emergency, so that he might make his calculations for his stops at water tanks, or at stations, and then have a little reserve on his brake. That would come in very conveniently for the emergency, and would answer all the purposes for which we require a driver brake. We want to increase the safety of our trains and to expedite the handling of them. The disposition is to run fast trains to get over the road quickly, to get started quickly, to stop quickly. Of course it is still available, as much as it would be where you apply the two. I think in the handling of our brakes, if we have them separate, there would be a great many times that we would not have to use them. There would be a great saving on our tires, and I think it would be worth a good deal in the case of an emergency.

MR. ALLEN COOKE—I was just going to mention that I had a side rod break awhile ago, and there was not any brake on the driver. (Laughter.)

MR. T. W. GENTRY—I am always inclined to agree with our friend Roberts, but I cannot agree with him in regard to the emergency feature of the brake. We made an extensive study of the subject. All of our passenger engines were equipped with driver brakes, and they had the emergency feature, as he calls it. We found on investigation that in nine cases out of ten the emergency failed to work. In fact one fellow had a cow jump up in front, and he slapped the brakes on his train and forgot the driver brakes, and when we inquired into the nature of the accident, we found the driver brake was not applied on the engine at all. We had numerous instances to show us that the very best possible use we could get out of our driver brake, was to have it applied every time we put brakes on our trains. Of course the new valve with equalizing arrangements provides for that. You have got your reserve right there.

MR. JOHN MACKENZIE—I would like to say something, to show Mr. Roberts that he is a little off on the wear of tires. What I would like to have, is something there to wear the tires a little more. Then we would not have to take the engines in so often. Notwithstanding the fact that we are using the

Ross-Meehan shoe, we find that the wear of the tire is faster where the rail strikes it, than it is where the shoe strikes it. I do not know of anything on our line for which the Master Mechanic would discharge a man sooner, than to see an engineer neglect to put on his driver brake. He is supposed to use it in every case, instead of the reversing lever, in moving round the yard. We have some eighty engines equipped with it, and they are requested to use it in moving every freight train. We find that it facilitates handling the trains a great deal. I do not know how our brakemen would make the stops, with 2,000 feet of train which we have on many of our engines, if it was not for the driver brake. I was not much of an advocate of the driver brake when we used the old style of shoe, but since the Ross shoe has been brought out, I have been very much of an advocate of it. We have some mogul engines on our road that made 75,000 miles without the tires being turned. I think they will make 25,000 more. I have no doubt that those engines would have been in the shop at least twice, for tire-turning, if it had not been for the use of the shoe and the driver brake. I do not believe we could handle a train successfully on our road if it was not for that. You take fifty cars with which you are supposed to make 25 miles an hour, and some of you have had enough experience to show how far a train will run with two brakemen to make the stops. We think that the driver brake is worth about seven brakemen in making stops. I am surprised that Mr. Roberts finds that his tires wear that way.

MR. R. H. BRIGGS—I was about to say, that the wear of tire depends very much on the amount of braking you have got to do. Mr. Mackenzie happens to be on a level road, or a road that is nearly level, and Mr. Roberts is right in the mountains, and we all know, that where train men know that there is what they call a "steam jam" on the engine, they are going to take it easy. It is my experience that the more steam jam you have the worse lot of brakemen you have. We know on our road that if there is a driver brake on an engine, the brakemen are not worth a cent. I believe that one quarter of our derailments in short curves on a rough track are caused by a free use of that "steam jam." Since the engineers have had positive orders not to use it when they are rounding curves on a rough track, our derailments have ceased entirely on such parts of the road. I believe with Mr. Roberts that you can use the "steam jam" too much.

MR. E. M. ROBERTS—I do not want anybody to get the impression that I am not in favor of driver brakes and in favor of a liberal use of them. I have not an engine but that has a driver brake. We allow our engineers to use the driver brake whenever they want to, but we expect them to use good judgment in handling it. But we expect the trainmen to hold the train as nicely as they can. If they do not control it nicely, we expect the engineer to come to their relief. I would like to have the valve separate so that the engineer can be the judge as to when is the best time to use it. Of course I am not an extensive user of the Westinghouse, but I have handled those things in my time, and I would always rather have one separate.

MR. L. C. NOBLE, Houston and Texas Central—I just wish to ask a

question of the gentlemen who had the trouble with the side rods and boxes, if they attributed it to the driver brake, and whether in the application of their brakes to the engines they are put on according to the instructions and drawings furnished by the Westinghouse Company. I have got a good many engines equipped with the brake. We use them on all occasions. We have no cut-outs. We have lots of stops. We do not have any trouble with the brake. They are all equipped according to the drawings.

MR. CHARLES BLACKWELL—I wish to call attention to the fact that the Committee recommended the use of the driver brake for making all stops, not for controlling the speed of trains in going down long grades. There must be a difference made there. If you attempt to control the speed of a train down a long grade by the use of a driving brake, the first thing you know you will have your tires loose, and that is the reason why Mr. Semple, of the Denver and Rio Grande, removed the driver brakes off his engines when he applied the Lechatelier brake. As regards the frequent use of the driver brake, I think that so long as you have not a plain surface to the shoe, a portion of which bears on the rail part of the tire, that no ill effects will be observed on the tire. Of course if the old style of shoe is used, bearing equally on all parts of the tread, you are going to wear your tire seriously, and you are going to have your engine go into the shop for tire turning in less time than it would, providing no driver brakes were on the engine.

MR. JOHN MACKENZIE—I just want to set Mr. Briggs right. The portion of the road on which the engines I referred to are running has a minimum grade of about seventy feet to the mile. That is where this great mileage has been made with the use of the Ross shoe. We have fifty miles that run—well, I think the highest is seventy feet. I think we run forty-two cars. I want Mr. Briggs to understand where this great mileage was made—something like seventy-five thousand miles to a sixteenth of an inch wear, and the probability is that we will get a hundred thousand miles out of those engines before they go into the shop.

MR. W. C. ARP, Chicago, St. Louis, and Pittsburgh—We had an engine 16 by 24 weighing about eighty thousand pounds, running on passenger service, which made 130,500 miles from the time the tire was new until the first turning, and with a wear of about 7-16 of an inch. We used the Ross brake shoe.

MR. J. S. MC CRUM—In regard to the wear where you use the Ross shoe, the question of the wear of the tire is not affected. While it is true in some instances that the driver brakes have a tendency to spoil the brakemen, I think that it is a matter that can be remedied by a little care on the part of the men handling the engine, and altogether I think that if you have a brake for an emergency brake, it is possible it may not be in efficient condition when you want it for an emergency if it is not used regularly. While we have engines equipped in both ways, having the driver brakes with the cut-out and without the cut-out, we are taking the cut-outs off as fast as we can do it.

MR. PETER H. PECK—I believe, as most do here, but I go farther than

that—I think there is hardly a wheel that rolls but should have something to stop on, I find that by putting on Ross-Meehan shoes we get along much better, and we do not have derailments since we got the driver brakes on. I am also in favor of putting them on the truck.

MR. R. H. BRIGGS—I do not wish to be understood in the remarks I made as being at all opposed to the use of the driver brake. It was merely the abuse of it that I was opposed to, and I claim that in nine cases out of ten the trainmen will take advantage of the driver brake and not attend to their duties, and the consequence is that there is a great deal more wear thrown on the tire by the abuse of it than there would be from the actual necessary use.

MR. GEORGE GIBBS—I merely want to ask the Committee the meaning of this clause in their report which states the ratio between the braking power and the pressure. As it reads here it might be the pressure on each shoe or the pressure on the two shoes.

MR. BLACKWELL—The pressure on each shoe.

MR. GIBBS—That is better, but it does not then seem too high to work.

MR. WILLIAM SWANSTON—I am in favor of the brake being applied from the one lever; that is the driver brake and the train brake. The multiplication of levers is calculated to confuse, and in an emergemcy not to be applied. As regards broken rods we have had quite a number. In the first six months I think probably I broke nearly a dozen rods. In a number of instances I attributed it to the rod being too long in service. In one or two instances I found that the shoe or the wedge rather had been very loose, and produced the effect that Mr. Briggs speaks of. Now as to the continuous brake—I mean the brake on four wheels on consolidation engines—I notice that most makers draw that pressure against the wedge. In my opinion that is wrong. The pressure ought to be brought against the shoe. The shoe is always permanent and cannot be laid down, and I think it is a very important feature and one that should be attended to. We use altogether the Ross steel shoe. We have found in a number of instances that the shoe has worn the tire slightly in excess of the wear of the rail. I have one engine now in the shop, that made a mileage of 168,000 miles without turning. The wear was about 20,000 miles to a sixteenth of an inch. It was a light passenger engine 16 by 24, and weighed about 70,000 pounds—about 50.000 pounds on the drivers. There is no doubt but what the Ross shoe has given us double the mileage between turnings.

MR. J. S. MCCRUM—I would like to ask Mr. Swanston whether he has discovered any difference in turning the tire after the use of the steel shoe and the ordinary Ross-Meehan shoe—whether they are more difficult to turn.

MR. SWANSTON—I never tried but two sets of the Ross-Meehan shoe, and I didn't get as good results as I did from the steel shoe. As to the tire turning, sometimes an average perhaps of one set in ten would have very hard spots, but whether that is to be attributed to the shoe or not I do not know. We turn all our tires by the piece and once in awhile a man com-

plains that he does not make any money, but he makes his average all the same.

MR. E. M. ROBERTS—I notice that these gentlemen who advocate the universal use of driver brakes acknowledge that they have accidents—engine rods off—pulling out the eye. Now, those are accidents that delay trains, besides being dangerous. That is what we have driver brakes for—to avoid accidents and prevent danger to trainmen and to passengers. Now, the question arises as Mr. Briggs says, are we going to abuse it and bring it into bad repute by damaging engines and causing accidents to our machinery, by a too liberal use of it.

MR. CHARLES BLACKWELL—I move that the discussion be closed.

The motion was carried.

AXLES FOR TENDERS OF HEAVY CAPACITY.

THE PRESIDENT—The special order that was interrupted yesterday will be the continuation of the discussion on the Dimensions of Axles for tenders of heavy capacity. This is a subject that is to come up in the Master Car Builders' Convention, and will no doubt be determined this session, and I think it highly important that the Master Mechanics should place themselves on record on this question. On motion of Mr. Lewis a recess of five minutes was taken. After the recess the President announced the subject before the meeting to be "Dimensions of Axles for tenders of heavy capacity."

MR. W. H. LEWIS, Chicago, Burlington and Northern—At the time of taking up this subject yesterday, I was not prepared with my blue prints to explain my views of the matter, and I am not prepared now with any set speech on the subject or any statistics as regards the strength of axles. The point that I take is, that from past experience and from our present practice, we are of the opinion that the strength is ample in the present M. C. B. axle. We at the present time allow cars to go over the lines loaded with from fifty thousand to fifty-five thousand pounds with the present M. C. B. axle, and I do not think that there is a gentleman present who has charge of the car department of a road that would hesitate in allowing a car to pass with a load of fifty thousand pounds on a sufficient sized M. C. B. axle. We have on our road 1,500 cars of 50,000 pounds capacity, running on the M. C. B. axle with journals 3¾ by 7 inches, and we have not had a single accident from axles breaking. We have had no trouble from axles bending. We frequently discover that those cars are loaded as high as 7,000 pounds in excess of their marked capacity—that is 57,000 pounds, and there has only been one instance that I remember where a car was set out on account of heating, that was overloaded in that way, but no accident resulted to it. Now, from that standpoint. I am satisfied that so far as the strength of the axle is concerned it is at present ample; but for the increased weight the journal is not. It has been decided by members of the Association that a pressure of 300 pounds per square inch of bearing is a reasonable pressure. We use a 3¾ by 7 inch journal. The pres-

sure under a 50,000 pound capacity car loaded to its capacity is equal to about 304 pounds to the square inch. The pressure of the bearing with a 60,000 pound capacity car, the bearing representing as it does 32 square inches, to each bearing, that is 256 square inches to carry a load of 60,000 pounds, which makes the bearing carry 312 pounds per square inch. That surely is not enough in excess to condemn the bearing. Now, the next aim is this—we wish to adopt the largest size practicable, without too radical a change in our present trucks and oil boxes. The axle that I show here, is the largest possible limit that can be used with our present standard without any change except of the journal bearing and wedge which would have to be changed in any event. We have a space of seven-eighths of an inch between the wheel and the back of the box. I have lengthened the bearing towards the wheel ¼ of an inch on the inside. I have lengthened the centre of the axle ½ an inch in extreme length making the distance between centres 6 feet 3½ inches. The total length of the axle is 7 feet and ¾ of an inch. You will notice that it gives us ample clearance between the end of the axle and the oil box cover. Now to allow for this quarter of an inch that we have spread the cen'res, which virtually brings the centre of the bearing ¼ of an inch from the true centre, I have coned the upper surface of the bearing, so that the bearing will come centrally on the wedge, making it really a centre bearing, notwithstanding that the centres are a ¼ of an inch in excess of the true centre. Now in the event of building a new truck with that axle, all that would be necessary would be, in putting on a 4 inch arch bar in place of a 3½, to make your allowance in your gib or lug on top of the box, and it would bring it exactly central, one lug being in the proper position. We can hardly realize the expense connected with the equipping of wheels and axles suitable for two different standards. With this sized axle it is practically interchangeable either with the present M. C. B. axle or with this, and if you did not have a 4 by 8 axle and did have a 3¾ by 7 that was up to the standard, you could use it in case of an emergency.

MR. S. H. HARRINGTON, New York, Lake Erie and Western—I am very much interested in the subject of axles for tenders. There is one thing particularly that we are interested in and that is the length from centre to centre of journals. I think if the axle is changed or increased to suit heavy tenders, the distance from centre to centre of journals ought to be retained the same as the Master Car Builders centres, I understand that this is 75½ inches. Now, there is a truck designed by Mr. Kells, superintendent of motive power of the Erie road, which I have brought along, as I thought it might be interesting, as well as the standard axle. The point that he tried to accomplish in designing this truck, was to put on 36 inch steel tired wheels for our large passenger tenders, and use the 33 inch wheels for all tenders and all cars of 50,000 pounds to 60,000 pounds capacity. We found it was necessary to design a box that would suit a 4 by 8 inch journal, and we have another that suits the Master Car Builders which was 3¾ by 7, if the axles are 75 inches from centre to centre of journal. The only peculiarity is in the construction of the box using the Morris box lid. But the ear of the box has a slot in it, and we have

designed a sort of L shaped bolt that by means of a lever that is made hook-shaped, an ordinary car inspector can press the point of the Morris lid, get the L shaped bolt around that gib, and it is impossible to get it out without the use of the lever. Those levers can be made for 15 to 20 cents apiece. What we want to figure on, is to use the same lid on all the 50,000 pound cars as well as tenders. The point we are most interested in, as I said before, if the size of the journal or axle is increased, is that the distance of 75 inches be maintained. There are several reasons for it, I think; one is to keep in stock one axle that will accommodate cars of less capacity, so that after they are worn down below the limit for a 60,000 pound car, they can be applied to cars of less capacity at the same time keeping in stock the same axles for tender trucks as we do for 60,000 pound cars. We have the Westinghouse brake beam for tenders with steel-tired wheels. We use a kind of Ross shoe without any head to it. It is all cast so as to slip on the end of the Westinghouse brake beam. Now, the dimensions of this axle I was telling you of, are almost those of the Master Car Builders'. The distance over all is 84½ inches, from centre to centre of journals 75 inches; the journals are 4 by 8. The wheel fit is 5⅛ and the axles are 4½ in the centre. We hope, if the Association sees fit to take up the standard axle, and recommend any increase, that they will maintain the Master Car Builders' standard of 75 inches.

MR. JAMES M. BOON—I am of opinion in the first place that whatever is used under passenger cars would be practicable for tenders. I do not think the matter of a collarless axle has been taken into consideration; that is, as much as its importance demands. Now, we are pretty generally aware that probably 75 per cent of the hot journals on tenders are due to the collars. That being the case, why not take the collar right off? This cast iron wedge on top of the brass-bearing looks to me like a relic of barbarism. Why not make the journal collarless? Make the brass wedge of one piece and let the brass slip over the end. On the West Shore the entire Pullman palace car equipment has this arrangement and it works satisfactorily. In fact I can not say we have any trouble whatever. You get increased bearing surface by it. Just as soon as that collar gets wearing against that brass there is going to be trouble. In considering this matter of a standard axle it may be wise to make an original change to find out just what is going to give the best result, and to remember that we are providing for all time. I would suggest that we take into consideration the question whether there is any merit in it, and give that fact due weight. It is possible that with these collarless journals the question of trucks will come up. It may be that the arch bars will have to be tied together. With a collarless journal, the thrust is taken on the end of the bearing. Connecting the two sides would be an improvement. The old truck has been a good truck in its time, but the question of increased weight and high speed has come so prominently to the front, that there is no question but that these trucks are hard to keep up, on a tender especially, with its constantly varying load. A tender will start out with probably 3,200 gallons of water and 5 or 6 tons of coal and it gets lighter, and the question of a tender

truck will come up so that the tender will ride equally well with heavy loads and light. I do not speak especially of this truck, but any truck to day that uses lumber is an expensive truck. We all know that oak lumber of a size sufficiently large to go into a heavy tender truck is very hard to get, and it is getting more scarce and more expensive every year. It should be borne in mind that the truck and axle go together, and we want a truck sufficiently strong to do the work, to be light and not to have a piece of lumber about it.

SECRETARY SINCLAIR—Mr. Boon, will you state what your preference is for the size of journal for heavy tenders and also the distance between centres of the axle?

MR. BOON—An 8 inch journal or 8½. Of course the size of the axle would depend on the load, but judging from the present capacity of cars and the weights we are carrying, an 8 inch journal or an 8½ by 4 would be ample. If I were going to leave the collar off, I would just make it whatever the collar was.

SECRETARY SINCLAIR—Mr. President, I am advised and I know from seeing it, that Mr. Thomas of the East Tennessee, Virginia and Georgia, has had a great deal of experience with collarless journals, and I have no doubt that the meeting would be edified by hearing what his experience has been.

MR. W. H. THOMAS, East Tennessee, Virginia and Georgia—I do not know that I can add much to what Mr. Boon has said excepting that I do not use the wedge he speaks of. I use a solid brass.

THE PRESIDENT—A solid brass wedge?

MR. THOMAS—No, a solid brass; we use no wedge at all. We have a cap on the end of the brass to assist in taking up this thrust. In connection with that we use a cast iron wedge or stop. The wedge is chilled on both sides, and we use the Master Car Builders' length of axle and turn the axle to 4½ in diameter by 8 inches in length. We have about ten or twelve thousand of them now running successfully; no trouble whatever.

THE PRESIDENT—In which direction do you increase the journal?

MR. THOMAS—We take the collar off and turn it back clear to the hub, making the diameter of the journal 4½ clear up to the hub. That gives us more room for sponging. We use no wedge—a plain brass.

THE PRESIDENT—Then you extend the brass over so that it forms a stop?

MR. THOMAS—Yes, sir, so that it forms a sort of stop. Then our boxes only clear the hub of the wheel about ¼ of an inch, so that after the stops and the lip at the end of the axle wear the box commences to touch the hub and gradually comes to a bearing. We find no difficulty in rounding sharp curves with heavy loads. There is no springing of arch bars or anything of that kind.

MR. CHARLES BLACKWELL—Mr. President, it appears to me that if you turn the axle and continue the same diameter of the journal 4½ inches up to the face of the hub, you are going to get a very weak point at the face of the hub. You are going to get a diameter at that point ¼ of an inch less than the present Master Car Builders' dimension there. The present dimension I believe of the dust guard of the fit is 4¾ inches.

MR. J. N. LAUDER—I like the principle of the journal as used by Mr. Thomas, with the single exception of the objection that Mr. Blackwell has urged. Now, I can see no reason why Mr. Thomas should not increase that journal to 4¾ inches. In other words, take the Master Car Builders' journal, which now is 4¾ in diameter where the dust guard comes, and 4¾ diameter of button, at the end of the axle. Now, turn it right out straight, instead of cutting down to 3¾ for the journal. Then, use a solid brass such as he speaks of. And right there let me ask what is that key used for?—simply to get your brass right over the collar with the Master Car Builders' journal. That is all the key is for. Without that key you could not get your brass off, because there is a button half an inch deep to prevent its sliding out. Now, with a collarless journal 4¾ inches in diameter, you do not need that extra piece over the box, because all you have to do is just to lift the weight off the journal and slip the box out. I cannot see why we should not go to 4¾ inches. It goes into the Master Car Builders' standard, because the outside of the box is precisely the same as the Master Car Builders' standard, with the exception that it has to be filed out in the front a little to get in the stop wedge. The inside of the box is precisely the Master Car Builders' standard without a single alteration, except the filing out in front and the slots inside to receive the stop wedge. It has this further advantage, that if a car with one of these collarless journals should become disabled on a foreign road, they can take a pair of wheels with the Master Car Builders' standard axle and standard journal at the present day and put them right in. There is a journal ample for all future requirements in my opinion—4¾ in diameter. That can be substituted for the present Master Car Builders' standard axle without a change of truck, without a change of anything, but just the housing and the brass, and you have got a 4¾ inch journal which it seems to me is ample for all use that we can see in the future. Now, the thing seems to me so plain, so simple and so effective that from my standpoint there ought not to be a dissenting voice. Why make it 4½ or 4¼ when you can just as well use 4¾ and use our present appliances? Jacob Johann, an old member of this Association, was the first man to do that. I think it is known generally as Johann's box, or Johann's journal. There is no patent on it. It is free for everybody to use. It is free for us to adopt, and free for us to use without any royalty, or patent suit, or anything of the kind, and so thoroughly complete in every way that I cannot see why we should not make it a standard.

MR. BLACKWELL—As regards the use of the collarless axle and in conjunction with it an end stop slotted unto the box, as I believe used by Mr. Johann —a loose stop—I have examined carefully tenders with his style of journal and I have noticed one objection. It is a very difficult matter to properly repack a box. If you get a hot box, the trainmen are very apt when they are pulling out or back to get this stop out, and when they are putting it back in a hurry, they sometimes forget to put that stop back. At any rate in repacking a box, supposing it does not get heated, it is a very difficult matter to get your packing around and under that stop. I think a lip at the end of the brass answers the

purpose fully as well as the cast iron loose stop. I have had considerable experience with that style of appliance in the South. The Central Railroad of Georgia has a large number of cars equipped with that style of bearing. It was introduced by Mr. Kline, the old Superintendent of the Road, but who is now on one of the Mexican roads, and I was astonished to see how long that lip would wear. I was expecting that the end thrust would be so great that the lip would be worn out a long time before the crown was worn out, but I found that the brass had to be scrapped before the lip was weak enough to throw away. In getting up some new trucks on that road, I provided for the possible breaking of the lips in service. I had tongues cast on the inside of the box, so that in case the lip were removed before the full mileage was made with the brass or before it was properly worn out, a stop could be dropped in there to enable you to wear out the brass. But so far it has not been necessary. That style of brass gives very good satisfaction, but I think that for 50,000 pounds you ought to increase the diameter of the dust-guard a little and not keep it at 4¾ inches the present diameter of the Master Car Builders' standard. I think 4⅞ inches would be better, if not 5 inches. In standard axles that I adopted on the Central Railroad of Georgia, I think I made the dust-guard 5 inches. Of course there is a difficulty,—if you want to introduce that axle into one of the old boxes you have got some chipping to do.

Mr. J. N. Lauder, Old Colony—I am very glad to hear the remarks of Mr. Blackwell, because if that lip on the brass will answer for an end stop, I think that you can use your old Master Car Builder's housing. Now, that is a good argument for doing away with this end-stop in the form of a key and using the lip, and it is also an additional argument in favor of that journal. I think it might be perhaps better if the shoulder could be made a little deeper. Of course, if the thrust comes on the brass, it is apt to wear into the ends of the brass on the top of the brass on those sholders. That could be easily made an eighth of an inch deeper, and then leave ample room to get the box out by jacking a little. I have had some trouble, or I did at first, with those end-stops—those wedges. I think, though, that I have got that obviated. I use cast iron with a chilled surface slightly oval to bear against the end of the journal, and the wear is very slight.

Mr. John Wilson—I would like to say, for the information of the members here, that we have used a collarless journal and a brass with an end-stop always on the main line, under our passenger-cars. It is a very old fashioned device. I believe it was originally patented by a man named Wright, a Yankee down here some place in New York State. He had us take them out once, though. We would not pay any royalty, and we had to get them all out. On the Kansas Division, they also run with an end-stop; but that device was a recess cast in the oil box. When Mr. Cushing came on to our road, we were having a great deal of trouble with our passenger equipment running hot, and what we objected to was this increasing weight of cars. We were building cars that were longer and heavier than any that we had had, and our people were very nervous. If you had the right kind of oil and every thing fitted up

rightly, they might run coolly, but if you did not they would run hot sure. We put in a new axle—one that we had in different service. We had found after seventeen years of service, what we considered serious objections to this brass with the end-stop. Mr. Cushing put in what Mr. Boon referred to—the Bissell wedge. It is a wedge where the brass is cast just as in an ordinary brass, but the wedge has the end-stop upon it. Now, we have run that for a long time on the Pullman trucks; and that in my judgment is much superior to the brass with an end-stop cast on it. There is one thing to which we have found quite an objection. In early years, when we had light cars and slow business, it did not develop; but, as we went along, it showed up from time to time. That was, when you were running at a very high speed, especially over our curves in the mountainous districts, the pressure was so great on the end of the brass, that it would take the latter out of a true parallel line with the axle, and we commenced in later years to find that a great many of our brasses, for no other cause than this, would wear a great deal more on the back end than they would on the front end. On the old Kansas Division we did not have that trouble, because the stop was put right into the oil-box. With the Bissell wedge, which we have also been using for years, this pressure does not come on to the journal bearing; it comes on to this key and by reason, if the key is made in two pieces, you can set it in the box deeper than if made in one. If we could not get this Bissell key in between the journal bearing with the end-stop cast on and the recess made in the oil-box to take the end-stop, I would much prefer the latter. It is true, that it makes it a little more troublesome about packing; but a car man soon gets over that. He gets his tools made the right shape. We do not have much trouble on the Kansas Division about that. At the same time it is a serious objection; and if the Master Car Builders could see their way, to adopt the best, I believe that the Bissell journal bearing and the stop wedge are the best in use at the present time. I would like to see more material going into this axle. With all due respect to the views that Mr. Lewis has put forward, which are very proper and right, and that is, not to throw away anything, but to work in all that we have as far as possible, I still believe that we ought to launch out regardless of every consequence, and get an axle which in the future will carry our loads safely at the speeds at which we expect to run. We have express freight trains on our roads now that run about as fast as our passenger cars, and I am sure that for a 60,000 pound car the axle is too small.

Mr. Gentry—I may have misunderstood Mr. Wilson, but I think I understood him as saying that with a bearing cast with the end-stop on it and with a force coming on the end-stop, there is a tendency to wear the bearing down thinner at the fillet.

Mr. Wilson—Yes.

Mr. Gentry—And you think that with the Bissell wedge which lies on top of that bearing and has this end-stop on the end, if it is turned down you find it less with that?

Mr. Wilson—Less, yes, sir.

Mr. Gentry—My experience does not agree altogether with yours. I

have never tried the bearing with the end-stop on it, but I have connecting roads that use it. We have found that same thing you speak of; but we found it with the Bissell wedge. It struck me, that when the end pressure came on the ordinary Bissell wedge, it just had the same tendency as though cast on there, lying right on top and in contact with the bearing. The Bissell wedge bore down just about as hard and probably with continual leverage a little bit harder than the brass with the end-stop cast in it. We attribute that wear of the dust-guard more to lack of lubrication and the fact that the dust-guard runs a little dryer, and that probably made our bearing wear thinner at the back. It never occurred to me that it was due to the thrust, or partly to both. I do not see that we relieve the wearing at that point by using the Bissell wedge. It strikes me that the pressure will be communicated through that separate piece just as it is to the bearing itself, or very nearly so.

MR. JOHN HICKEY—In selecting an axle for 50,000 and 60,000-pound cars, it would be well to keep in mind that we may get a journal having too large a diameter. Mr. Lauder speaks of 4¾. The journal being made 4¾, of course would entail, in order to get a collar at the back end, to make the dust-guard ⅝ of an inch larger in diameter, and the wheel fit proportionately larger. We would therefore get a very large axle, and in that way we may get an axle that would be too large. Now, in talking of this matter in the Western Railway Club—it has been up several times—the subject was fully looked over, and we reached the conclusion that an axle 4¼ inches in diameter will answer every purpose for 50,000, 55,000, or 60,000-pound cars. It would be less in weight, and there would be less frictional resistance. If 3¾ is proper for 40,000-pound cars, 4¼, by the same ratio of figuring, would be right for a 60,000-pound car. Enlarging the journal would entail enlarging the other parts of the axle.

MR. JOHN MACKENZIE—I called attention to a paper that one of the members had here yesterday, and I would like to have him tell us the capacity of the different sized axles as compared with the Master Car Builders' standard. Mr. Gibbs is the gentleman I referred to.

MR. GIBBS—This table that I got up is not for that purpose. It was an attempt to show the pressure per square inch on the journal with different sized axles under 60,000 to 40,000-pound cars, and then we figured out, by the German experiments, what pressure would come on a car from the side action of the car in going around curves. Then assuming that the journal in any given proportion was the right one for speed, we proportioned the other diameters at the wheel seat and center to correspond. But we have no figures to show that even the smallest Master Car Builders' journal, 3¾ by 7, is not large enough in its full size and in good condition to carry a 60,000-pound car. But the point is, that we must enlarge the journal to carry the car without heating, and then comes the question: How shall we do that? Shall we increase the area by increasing the length of the journal, or the diameter, or both? In the Western Railway Club and other parts of the country, opinion seems to be divided on

that point. Personally I am in favor of increasing the journal rather than the length in the axle. Mr. Lewis has brought up the fact that it will fit in the present Master Car Builders' box without any change whatever. Other members in speaking of the subject have mentioned that as an advantage. Mr. Lauder spoke of 4¾ being able to get into the present box. I think we ought rather to provide for using that axle after it gets too small—using it in cars of smaller capacity, and in none of those axles will this be possible without considerable labor in the machine shop or a change in the box. The axle which we proposed to bring forward for the consideration of the Master Car Builders, for use under 50,000 and 60,000-pound cars, was a 4½ by 7 inch collared journal, which gives about the same pressure per square inch as the 4 by 8 journal. We propose a collared journal, because in the present diamond truck, we do not believe that the end-thrust can be safely taken on one collar only, without causing the thrust to act in some way that is not provided for. I have not seen that point brought up this morning in connection with freight service. In the passenger service we know that we can use collarless journals, although I must say we have had some trouble with them.

MR. BLACKWELL—The cars I refer to as running on a certain Southern load, belong both to passenger and freight service. We did not experience any serious difficulty from any distortion of the truck by the thrust coming on one side only.

MR. MACKENZIE—The problem of an axle for a 60,000 pound car, seems to me to be one that is going to give us a good deal of trouble in order to get the axle, and then when we get the axle we are going to have a good deal of trouble about the truck. If the truck is strong enough only to carry 40,000 pounds, it will not carry 60,000 pounds, any more than the axle will. I think that this talk of designing an axle to go into a 40,000 pound car is all wrong. If we want a truck to carry 60,000 pounds, we have got to build one. In designing an axle to carry 60,000 pounds, we design a truck to carry 60,000 pounds. We do not care whether the Master Car Builders design an axle for a 60,000-pound car or not; we are not going to use it in our 40,000-pound cars. I can not understand why the question of getting that axle so that it will go into the Master Car Builders box, has any thing to do with it. What you want is a ruck for a 60,000-pound car with an axle and with the other parts designed the same as you would design your axle.

MR. COOKE—This axle business and truck business have been talked upon for a long time at our Club meetings in Chicago. I think if they would let go with a sixteen-ton car and go on and build a truck to carry 60,000 pounds, we would not have a great deal of trouble. It is something like six-foot gauge; we thought we were going to come to a standard gauge. We did everything. We made our cylinders separate with a bed plate between them. If we were going back to a 15 or 16 ton car some day I think it would be well to cipher around in this manner; but, as long as we do not think of going back to these 15-ton cars, you do not see any being built now in the car shops—they are all going to get rotten, and what is not rotten will be stuff for selling to some road

that does not want to do any business. You will not have any cars to put these axles in. I have shipped off lots of this kind of axle. I can not see why they want to put them into the Master Car Builders' box. The box is not big enough. You want to put in some waste and oil, if you want to carry thirty tons. Years ago when we carted locomotives on the Castle flats we used to have a five-inch axle. They wanted it for carrying thirty tons. Now, they want to carry this load on a 3¾ by 7 inch journal; or they want to put the big axle into a gimlet hole, where you can not have any waste or oil. I have heard so much of it in Chicago that I have got rather sick of it. When I built a thirty-ton car I concluded I had got to have something to carry thirty tons, and I went on and built a car that I thought would carry it. (Applause.)

MR. R. H. BRIGGS—I never heard of a man commencing to build a house and leaving the last brick in the chimney. Evidently the motive that prompted that committee to do this work and make this report was to get something to take place in the weak point. We all know the great trouble with our cars, especially freight cars, has been weak axles, and it is perfectly natural to suppose that the committee would attend to that weak point first. I think the suggestion which the committee has made is perfectly consistent and right under the circumstances. I am willing to admit that improvements can be made in the truck, but we want a stronger axle evidently. The difficulty of broken axles is growing every day. We do not hear so much of broken trucks, and if you can utilize in building what we want some portions of the Master Car Builders' truck, what objection is there to it? If we find out that there is not room enough for packing we will get to work on an oil box, and if the arch bars are not strong enough let us work on the arch bars. After a while we will get the house complete—in other words a perfect truck. I think that the discussion on axles and the proposed increase of size is perfectly consistent, and one that we ought to entertain by all means and not to put it down by any ridicule.

MR. JOHN MACKENZIE—I agree with Mr Briggs in one particular, and that is, that we want a larger axle. But we do not want to put more weight upon it. We want a larger axle to carry 40,000 pounds. I am like Mr. Lauder, I have a number of engines on the road with 4¾ inch journals. They are said to be Johann boxes, but they are not. Anyone who saw a Rodgers engine thirty years ago, saw provision made to take the thrust on the outside of the axle. We put the 4¾ inch journal into the oil box and we find that we are crowded for space. In making another oil box for the tender, we design to drop it down from forward and back of the arch bar to give us an oil pocket down there. That is what we want for our tenders, but we shall not do it for the cars. Now there is only one thing to be said against the thrust plate, and that is that the trainmen are apt to throw it out and not put it back again. The box can be packed much better when the thrust plate is taken out than it can with the collar on for that matter. But if we put this large axle in we prevent a great many hot boxes, and it will not be necessary to take so many of the plates out. But we are all wrong in talking about introducing a heavy axle into the present truck. I want to call Mr. Briggs' attention to this fact, that

there are very few of the Master Car Builders' axles that break under any load, but there are a great many trucks that are breaking. I will venture to say that out of the 7,000 cars that we run ten trucks break down to one axle. Now then it is not the axle that is too light in that case, is it? And if we introduce more load on that truck what will the consequence be? It will not be ten trucks but it will be twenty trucks breaking to one axle. If we want a 60,000 car, as Mr. Cooke says, we want to build a 60,000 pound truck.

MR. BRIGGS—My idea was, that the discussion was on an improved axle—not truck. I do not deny what our friend Mackenzie says, but we were talking of an axle exclusively, I supposed.

MR. LEWIS—From the way the gentlemen started out here, it seemed to me, for a time, that I did not have a friend in the room until Mr. Briggs got up, and it was like the dew of heaven to the barren earth. Now the burden of their position has been that we do not want to use this axle in the old scraps of trucks They do not consider the fact, that we have thousands and thousands of cars and trucks all over this country with that size of journal. Now if the truck itself is not strong enough to stand 50,000 or 60,000 capacity, increase the size of your truck. The increasing of the strength of the truck does not increase the parts. It does not necessitate throwing away everything that there is in the construction of the truck and adopting something else. It fact, it does not compel you to scrap the entire equipment of this country. What I aimed at doing, was to adopt an axle just as large as it was possible to run it with our present proportions and I think I have done it. There is no question in my mind about the strength of the axle being perfectly sufficient for cars of 60,000 pounds capacity. As I said before, we have 1,500 cars of 50,000 pounds capacity that are running on a 4¾ by 7 inch journal, and we do not have any trouble with the axles bending or breaking, and the only trouble we have ever had has been with the journal heating occasionally under excessive load. Now here is another point in that connection: If a 4 by 8 journal is large enough to carry that load, what is the sense of making it 4¼, 4½, or 4¾ by 8 inches? When you increase the outside diameter of the journal, you increase the revolving friction on that journal, and you increase the momentum of the wearing parts. Why do you do it? Why is it necessary, if 4 inches is large enough, to make it 4¼? I still contend that the most desirable thing to do at present, is to adopt an axle which will be interchangeable with our present equipment. Now with regard to the collarless journal. If any of these gentlemen prefer a collarless journal, it is their privilege to use it but its success is doubtful, and I will tell you why. It is the point Mr. Gibbs raised in connection with the end thrust of the truck. Now as you all know the collarless journal, as a rule, was applied to passenger equipment. Passenger equipment is composed of trucks with each side tied together and with strong pedestals to it. The diamond truck is supported in the centre with the ends unsupported. Now without the ends supported by the end sills, the collar of the journal serves to tie that truck together. In the case of derailment a wheel on one side becomes locked in the guard-rail or switch rail and the leading rail on the other side carries the wheel

off. What is the effect? The effect is to spread the truck frame and distort it; whereas if you had the support of a collar on the other side it would preserve the truck.

MR. HARRINGTON—As to the point brought up about interchangeability, I still think that it does not pay after an axle is worn down from 60,000 pounds capacity to throw it away. Mr. Kells designed this truck which I mention. He had that one object in view to follow out the Master Car Builders' standard as far as possible. There are many cars on the Erie road of less capacity that would take this axle after it is worn down below the capacity for which it was originally intended. We do not care so much for the M. C. B. box as to use that axle. We do not have to keep in stock a lot of axles for tenders, and furthermore we are able to use the axles on foreign cars, providing they stick to the Master Car Builders standard. I think that no matter if the axle is to be increased either in length of journal or diameter of journal, we ought to maintain the standard from centre to centre, which is 75 inches.

THE PRESIDENT—The hour for the discussion of miscellaneous questions has expired. Do you wish to make any disposition of this?

MR. MACKENZIE—I move that the discussion be closed.

The motion was carried.

After a short discussion about the next business to be taken up it was decided that the report on "Foundation Ring for boiler leg," should be read first.

Mr. Lauder accordingly read the following report of the committee.

REPORT OF COMMITTEE ON FOUNDATION RING FOR BOILER LEG—BEST FORM AND ADVISABILITY OF DOUBLE RIVETING.

In considering the question of the best method of joining the furnace-plates with the shell-plates at the bottom of the boiler leg of a locomotive boiler, the matter of first cost should be taken as a minor consideration; the obtaining of a joint that shall be durable and perfect being the all-important object, and this, when found and adopted, will, in the end, prove most economical.

The members of this Association well know how troublesome and expensive a thing is a leaky foundation ring, and how it sometimes leads to the destruction of the boiler-plates in the vicinity of such leaks, and the consequent corner patch becomes necessary. When patching commences, a new furnace is soon needed. The almost universal practice in this country has been to use a plain, rectangular bar of iron (drawing No. 10), with depth enough to take one row of 3/4-inch rivets. The only merit

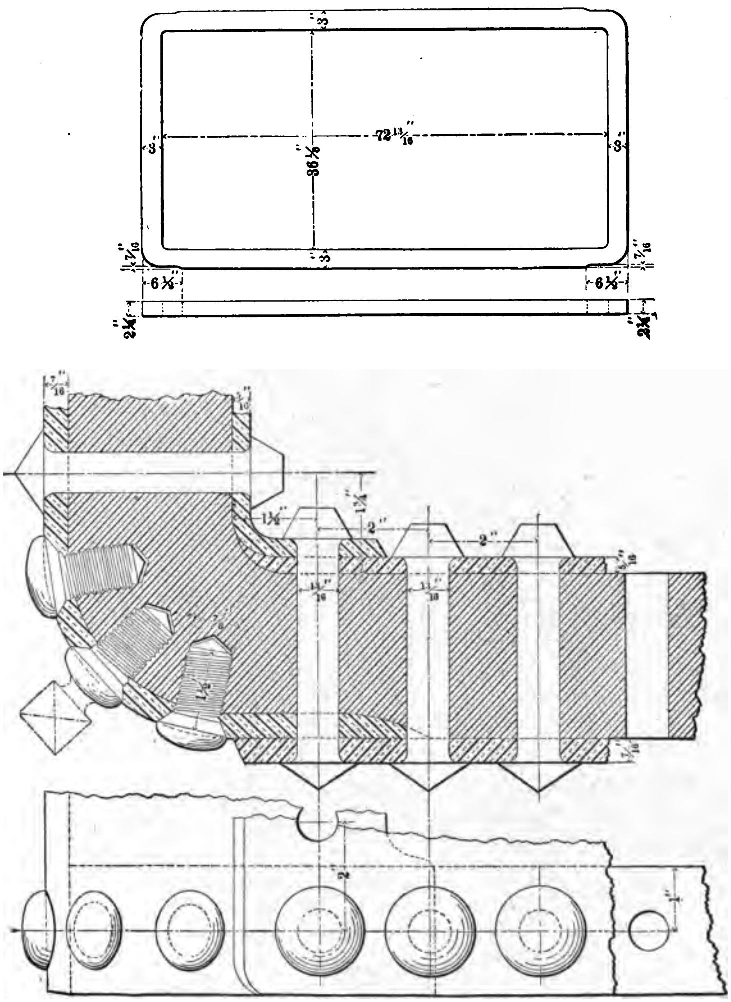


FIG. 10.

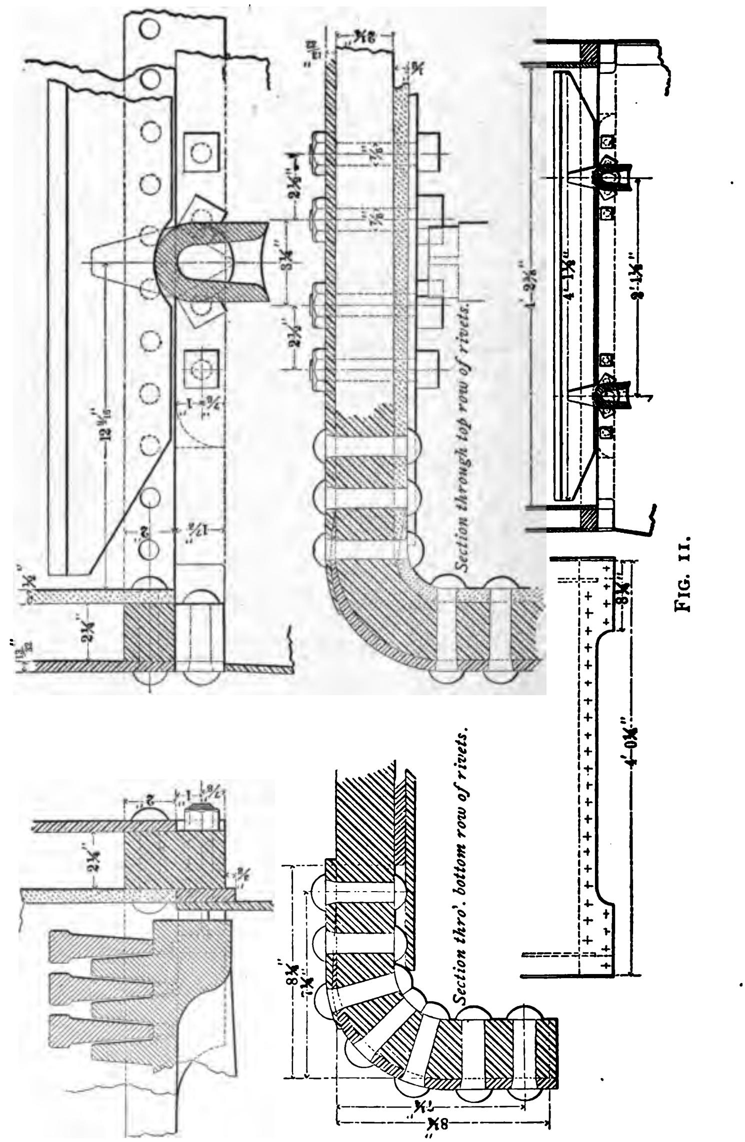

Section through top row of rivets.
Section thro'. bottom row of rivets.

FIG. 11.

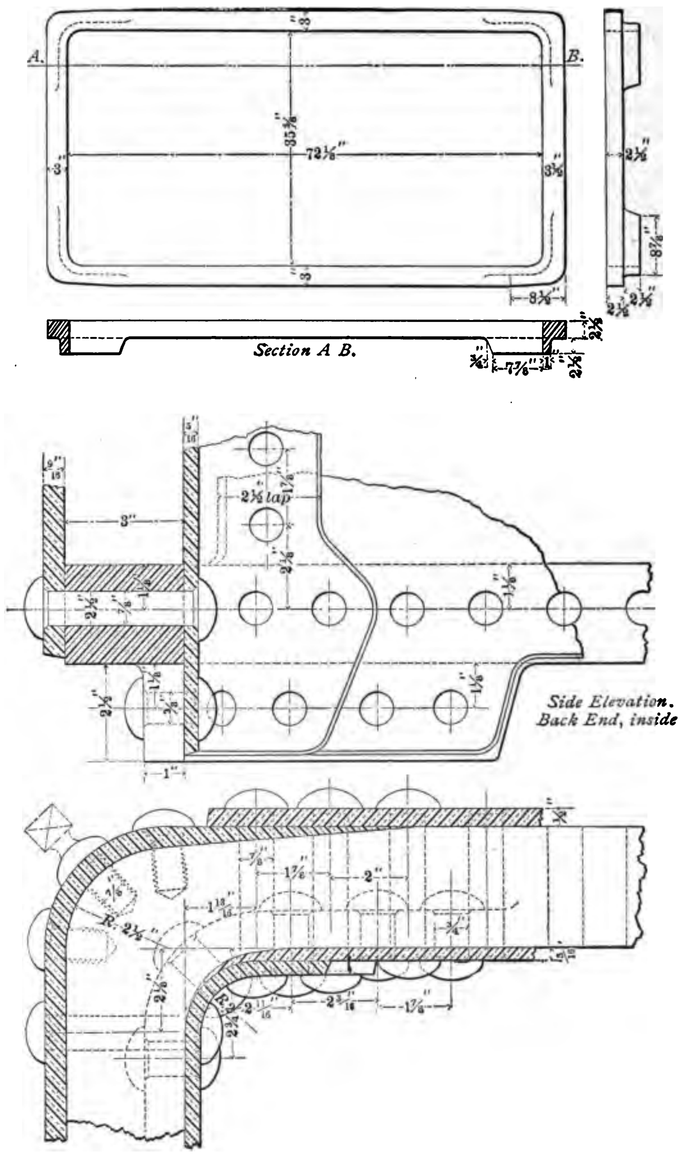


FIG. 12.

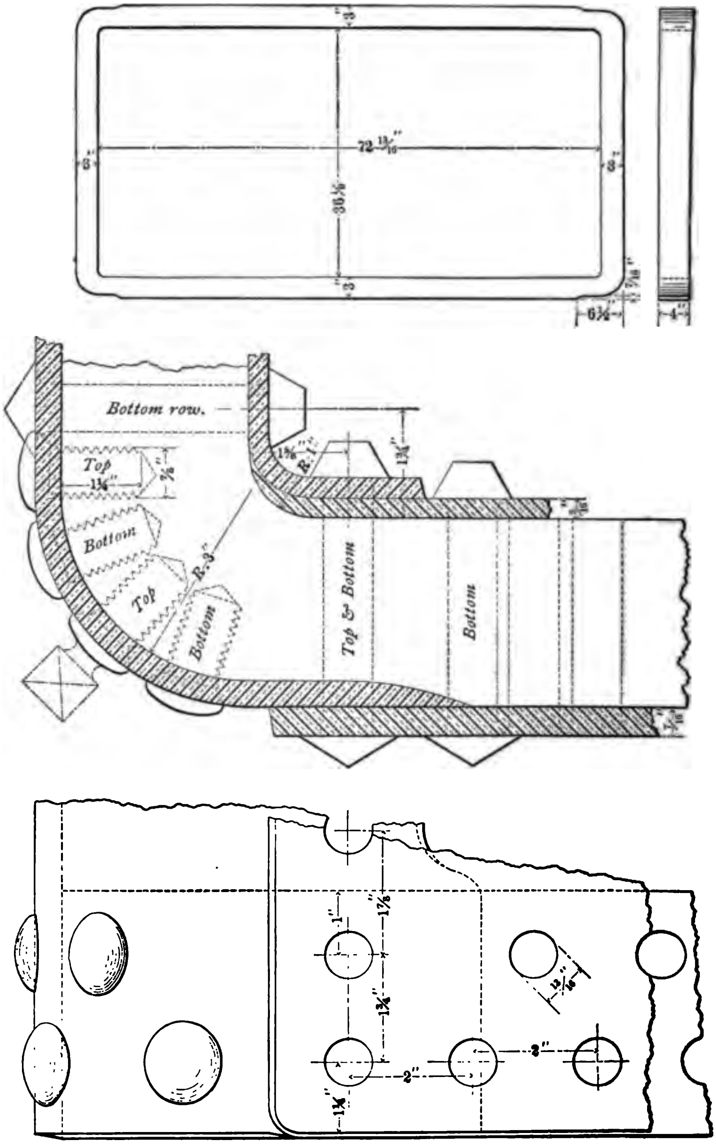


FIG. 13.

this system possesses is its cheapness in first cost, and many unscrupulous builders bend the corners without upsetting the bar, and, in consequence, the ring at the corners is so reduced in thickness vertically that it will hardly hold water when new, and when put in service the strains of unequal expansion will very soon produce leaks. Until recently there seems to have been very little effort made to correct this evil, but we have gone on apparently with the idea that this defect was inherent in the locomotive type of boiler, and could not be remedied.

In Europe a variety of methods of construction have been tried with varying degrees of success. A plan, shown in drawing No. 11, was furnished your committee by Mr. Webb, of the London & Northwestern Railway. An examination of this plan will show that the outside plate at the corners is double riveted, while the inside furnace-plate is fastened with a single row of rivets in the usual manner. Our experience and observation, based on practice in this country, would lead us to condemn this method, as the joints of the inside plates at the corners are those that give the greatest trouble from leaking ; but the difference in practice may be accounted for by the fact that Mr. Webb uses copper for his furnaces, while in this country steel is used. Another method, shown in drawing No. 12, is used as a standard by the Canadian Pacific Railway, and to a limited extent by several roads in the United States, notably the New York, Chicago & St. Louis, and it doubtless possesses merit as far as the corners are concerned. But the remainder of the ring is simply the plain, single riveted foundation ring, and is sure to develop leaks at other points than the corners, especially when the quality of the water used is poor.

The system of construction of locomotive boilers wherein the furnace of the boiler is placed over the frame, is rapidly coming into use, and the foundation-ring construction just mentioned would be, with this system, an annoyance. Placing the furnace over the frame increases the necessity for thorough construction of the bottom of the furnace, as leaks at that point, especially at the corners, are difficult to repair without raising the boiler from the frame, which entails a heavy expense.

Efforts are also being made to improve the ordinary method by making the ring deep enough to receive the two rows of rivets

through it all round. This method, shown in drawing No. 13, your committee believe to be the best yet used, as it makes a strong and thorough mechanical job, and if the ring at the corners is properly prepared and the riveting well done, will never leak. Much depends on having the ring well prepared to receive the plates, and your committee believe that the expense of machining the ring around the corners, both outside and inside, will prove an excellent investment. Poor workmanship, with any design of foundation ring, will give trouble; and in drawing specifications great care should be taken to bind the builders very closely in the design, and the workmanship should be carefully inspected as the work of building progresses.

In conclusion, your committee would recommend a double riveted foundation ring, substantially as shown in drawing No. 13.

J. N. LAUDER,
W. J. ROBERTSON, } Committee.
H. TANDY,

On motion of Mr. Briggs the report was received.

APPOINTMENT OF COMMITTEE ON NEXT PLACE OF MEETING

THE PRESIDENT—The report is now before you for discussion. The drawings pertaining to this report are not here and it only lacks a few moments of the hour for adjournment. I will say that there is a committee to be appointed on the next place of meeting, and I will appoint on that committee James Meehan, J. N. Lauder and John Hickey.

MR. GEORGE RICHARDS ELECTED AN HONORARY MEMBER.

MR. LAUDER—Inasmuch as the drawings which accompany that report are not here I would move that the discussion of the report be postponed until to-morrow, and I would also ask unanimous consent to present a resolution at this time.

THE PRESIDENT—Can the gentleman have the unanimous consent to introduce a resolution? There being no objection it will be taken for granted.

MR. LAUDER—I would like to present a resolution like this:

Resolved That our present treasurer, an old and valued member of this association, Mr. George Richards, be placed upon the honorary list of the roll of members of this association.

MR. BARNETT—I beg to second that motion.

THE PRESIDENT—A motion has been made by Mr. Lauder and seconded by Mr. Barnett that our treasurer, who is one of the oldest members of this association, be placed upon the list of honorary members. Any remarks will be in order.

MR. MACKENZIE—Mr. President, I suggest that we have a standing vote.

The resolution was unanimously adopted by a standing vote.

MR. JOHN THOMPSON ELECTED AN HONORARY MEMBER.

SECRETARY SINCLAIR—Mr. President, while this subject is up another name may be brought up, I presume, if there is no objection?

THE PRESIDENT—There is no objection.

MR. O. STEWART—I would also ask for the privilege of introducing a resolution of this kind.

Resolved That this association place upon its list of honorary members the name of John Thompson.

The motion was seconded by Mr. Sinclair and unanimously carried by a rising vote.

The convention then adjourned until the following day at 9 A. M.

THIRD DAY.

ROUTINE BUSINESS.

The convention was called to order at 9:15 A. M.

THE PRESIDENT—The first business in order this morning is the discussion of the report that was read yesterday at the hour of adjournment—Foundation Ring for Boiler Leg, Best Form and Advisibility of Double Riveting.

SECRETARY SINCLAIR—I may explain to the members that the drawings connected with the report are up there on the door and the lower one is the method of riveting recommended for the corner of the fire-box. Several of the parties most interested in this report are not in. If there is some routine business to go through that might be taken up.

THE PRESIDENT—If there is no objection the matter will be deferred and miscellaneous business taken up.

SECRETARY SINCLAIR—There is a letter here from a gentleman in Buffalo requesting that the next convention meet at that place.

THE PRESIDENT—What will you do with the communication?

A MEMBER—I move to refer it to the Committee on next place of meeting.

The motion was carried.

ELECTION OF ASSOCIATE MEMBERS.

SECRETARY SINCLAIR—I have here two applications for Associate Membership.

To the Executive Committee:

We would most respectfully recommend the name of J. Y. Smith for election as Associate Member of the Master Mechanics' Association.

(Signed) J. N. LAUDER.
JOHN MACKENZIE.
N. E. CHAPMAN.

The matter was submitted to the Executive Committee and they unanimously recommended the gentleman's election. Of course it is left for the meeting to decide.

The candidate was balloted for and unanimously elected an associate member.

The secretary read the following:

To the Executive Committee:

We would most respectfully recommend the name of John A. Hill as an associate member of this association.

(Signed) J. H. SETCHEL.
J. S. MCCRUM.
PETER H. PECK.

SECRETARY SINCLAIR — The Executive Committee also recommend unanimously that Mr. Hill be elected an associate member.

On motion the report was received.

A ballot was taken and Mr. Hill was unanimously elected an associate member.

The secretary read a letter signed by the members of the committee on Exhaust Pipes and Nozzles expressing their regret for not having been able to complete their report.

THE PRESIDENT—If there is no objection the paper will be filed, as the committee has been continued.

DISCUSSION OF REPORT ON FOUNDATION RINGS.

THE PRESIDENT—Now, gentlemen, the regular business in order is the discussion of the fire box ring of locomotives. Is there any discussion on this subject? Mr. Gibbs, haven't you anything to say about it?

MR. GIBBS—I do not know that I have, Mr. President. We single rivet our rings in the fire boxes and double plate inside the corners. Our custom has been heretofore to forge the rings with a deepened corner at that point so that we could counter-sink all rivets on the inside sheet—two rivets inside of the corner. On going over the engines we have decided to leave off that projection, but still continue to lap the inside sheet—cut that inside sheet with a long lap on the corner so that you can get two rivets on the corner there in a single row; but to obtain the projecting corner—that gives trouble in forging and cutting the sheets and fitting the ash pan. We can not see that it has any particular advantage. It makes a very rigid corner there.

MR. PECK—My experience with the extended corners is the same as Mr. Gibbs'. We cut them off. I find that the iron rusts between the two rivets and rusts off fully as quickly as it did on single rivets. In recent engines I have ordered built I have left that off.

THE PRESIDENT—Mr. Arp, can you tell us something about mud rings?

MR. ARP—We use the single rivet all the year round. There is no doubt but what there could some improvement be made, and I would like to hear something about that from others.

MR. WILSON—I think that the report which the committee made on this subject suggests some improvement on the ring, and I believe that everybody who has tried the recommendation they make, find it an improvement. I think the report is very clear on that point. I refer to the milling or the machining of the ring and the double riveting.

THE PRESIDENT—The recommendation of the committee is a double rivetted foundation ring substantially as shown in drawing No. 13.

On motion of Mr. Blackwell the discussion was closed.

THE PRESIDENT—The next regular business in order is the reading of the report on the best Proportion of Grate and Flue Area. Mr. Barnett will read the report.

Mr. Barnett read the following report :

REPORT OF COMMITTEE ON BEST PROPORTION OF GRATE AND FLUE AREA.

The subject assigned your committee is one requiring extensive experiment if satisfactory conclusions are to be arrived at. Its members had not the leisure, much less the means, to carry out such experiments ; in fact, a grant from the National Treasury would be required to cover so heavy an outlay. But it was very naturally supposed that some of our association members might have tried individual experiments by varying a normal type of boiler at some single point, and noting the effect of the variation.

With this hope your committee issued a Circular of Inquiry (see Appendix C). A summary of the few replies received is as follows :

TUBE (HEATING SURFACE) AREA.

Two have varied the tubes in boilers of similar size, viz, Mr. H. Schlacks, who added ten more tubes, improving its steaming qualities, but as the crown-sheet and tube-sheet were widened to get these tubes in, it can not definitely be said to which of these changes the improvement is due ; and Mr. G. W. Stevens, who, on a 17-inch x 24-inch x 5-foot passenger engine, changed the boiler from 147 flues, 2¼ inches diameter, to 212 of 1¾ inches diameter, the length, 11 feet 6 inches, remaining unaltered. This increased the external flue surface from 995 feet to 1,116 feet, or 121 feet—equal to 12 per cent—with an increased water evaporation of practically 7½ per cent., and after two years' experience he is able to report that the smaller size flues are not any more troublesome in the matter of stopping up than the larger flues, and also that they are less disposed to leak.

Mr. F. B. Twombley has in hand an experiment which, it is hoped, will be so far advanced in June that he will be able to give a personal report.

GRATE SURFACE.

Our queries in this matter were framed with the purpose of finding out the modifying effect of altering the amount of grate surface.

Mr. H. Schlacks reports lengthening grates (and furnaces) from 60 inches to 66 inches, keeping every other point unchanged, but he cannot note any appreciable difference in their efficiencies; and thinks it is possible to give a boiler too large a grate surface.

Mr. Wm. Garstang has 58-inch boilers, with 72-inch and 78-inch lengths of grates. Those with the longest grates are the freest steamers, but the coal consumption is about the same. However, any conclusions to be drawn from this example have to be modified by the knowledge that the longer grate has the fewer flues by 9 per cent., although they are spaced wider apart by 20 per cent. The figures are: For the short grate, 244 flues spaced 5/8 inch apart, and for long fire-box, 221, spaced 3/4 inch apart.

On the general question of grate surface he thinks it is possible to get too large a surface if the coal is good.

Mr. O. Stewart reports reducing Baldwin Consolidation grates and furnaces from 120 inches to 96 inches and using a 16-inch dead-plate in front, so that the effective grate is but 80 inches long. This experiment was so satisfactory that the whole class now have their grates reduced to these figures.

On the general question of grate-surface, four others say it is not possible to give too large a surface (under the limiting conditions).

No one has experimented in the direction of reducing medium or short grates, with the hope of making combustion more rapid and thus attaining a more economical result, as, for instance, has been done in exceptional cases with some stationary and portable boilers, to their evident improvement. In exhibition contests with portable engines, reducing grate area is a favorite means of jockeying used by some wide awake competitors.

Query No. 6 has been variously understood and interpreted. Mr. W. A. Foster under all circumstances would make the grate surface as large as possible independent of heating surface. Mr. Garstang gives 90 feet of surface to one of grate, and Mr. Schlacks from 60-65 to 1. Mr. Barnes would give a gas open-

ing through the flues as compared with grate of 3 to 1 for 17-inch cylindered engines.

DEAD PLATES.

The question about dead plates was not generally understood, as it was commonly remarked in the replies that dead plates are put in front end of grates usually to prevent the strong blast from drawing in too much air close to flue sheet. However, Mr Schlacks reports taking the dead plates out at back end of grate and improving the steaming, the air spaces between bars remaining unaltered; and Mr. M. Ellis removed dead plate and changed the bars, giving 56 square inches air opening per square foot of grate, instead of 47, with satisfactory results.

INTENSITY OF COMBUSTION.

No figures for comparison are given in the replies, and opinion is divided on the question of the comparative economy between slow and rapid combustion.

COAL BURNT PER SQUARE FOOT OF GRATE.

Mr. Schlacks says it is impossible to assign a limit, the best practice varying from 55 to 73 pounds per square foot of grate, and Mr. Ellis says he consumes 120 pounds, with a heating surface of 74 to 1 of grate.

EVAPORATION.

Mr. Allen Cooke gets from 7 to 9 pounds of water, Mr. Schlacks from 5½ to 6, and Mr. Ellis' best record is 8.54 from and at a temperature of 65 degrees Fahr.

In conclusion we would say that the small amount of information obtainable from the Association provoked your committee to look elsewhere, and two of its members make personal contributions as per appendixes A and B, attached.

J. DAVIS BARNETT,
F. W. DEAN.
PHILIP WALLIS.

Appendix A.

VALUE OF FLUE AREA.

The early experimenters in this and allied fields of investigation were Mr. C. W. Williams, Mr. J. Graham, M. Petiet and the Engineers of the Northern of France.

M. Paul Harvey carefully analyzed this experimental data (*Annales des Génie Civil*, 1874) establishing for *flue evaporation* the following law: "The quantities of water, evaporated by consecutive lengths of tubes, decrease in geometrical progression, whilst the distances from the commencement of the series increase in arithmetical progression. From which it follows that the ratio between the quantities of water evaporated by consecutive equal lengths is a constant number, N. These ratios are expressed by the equation,

$$Q_L = Q^o N^L,$$

in which Q_L is the quantity of water evaporated by the $(L+1)$ length; that evaporated by the first length being $= Qo$.

The point at which this law begins to prevail is that at which the radiation of heat from the fuel ceases, and heat is communicated by conduction alone; and it appears from the observations cited that in locomotive boilers the evaporation diminishes by nearly one-half for each 3 feet of length. Therefore the value of N in the above formula would be 0.5.

The early experiments (1842) of Mr. E. Woods and Mr. J. Dewrance were on a short boiler without strong draught. The first length of tube (6 inches) was per foot of surface almost as effective as the fire-box; the second length (12 inches) had about a third of that value. The other three divisions (12 inches each) did little evaporative work, so that the first 6 inches did more work than the remaining 60 inches length of flue. The fuel in all experiments was superior to our common soft coal.

Mr. D. K. Clarke in 1852 published his often quoted deductions, laying much emphasis on *grate surface*, saying, 1st, that the evaporative work of a locomotive *decreased* directly as the grate area increased. 2d. That it *increased* directly as the square of the heating surface, with the same area of grate. 3d. That the necessary heating surface *increased* directly as the

square root of the performance; that is to say, for example, for four times the water evaporated (with the same efficiency) only twice the heating surface is required. And 4th, the necessary heating surface increases directly as the square root of the grate, with the same efficiency; that is to say, for instance, if the grate be enlarged to four times its first area, twice the heating surface would be required for the same evaporative performance, with the same efficiency of fuel.

He in effect stated there can never be too much heating surface but there may be too little; and that, on the contrary, there may be too much grate area but cannot be too little, so long as the required rate of combustion per square foot does not exceed the limits imposed by physical conditions.

His general formula for the relation of coal consumed and water evaporated per square foot of grate area per hour is

$$w = .009r^2 + 9.7\,c.$$

Where w = the equivalent quantity of water evaporated in pounds per square foot of grate per hour from and at 212 degrees Fahrenheit, c = the quantity of coal in pounds consumed per square foot of grate per hour, and r = the surface ratio, or the ratio of heating surface to the area of grate.

Of course, there are limits to the application of such a formula, and it would probably give incorrect results for fuel being consumed at the high rate of 120 pounds per square foot of grate.

More recently, Mr. J. A. Longridge, not being satisfied with any existing formula, endeavored to base one upon the well-known laws of combustion and upon the law of transmission of heat through metallic plates. These laws may be expressed as follows: The quantity of heat transmitted through a metallic plate is proportionate to the area of the plate and to the difference of temperature of the medium on one side from that on the other. The quantity of heat developed by the combustion of one pound of fuel is accurately known, as are also the weight of the gases arising from the combustion and their specific heat. It is also generally allowed that, in order to have perfect combustion, about one-third on the air admitted must pass away undecomposed. The quantity of heat, in units, generated by the combustion of one pound of fuel can therefore be determined, and the disposal

of this heat is the problem to be dealt with. Now, the heat is disposed of as follows: Firstly, by radiation from the boiler; secondly, by transmission into the water through the surface of the fire-box; thirdly, by transmission into the water through the tube surface, and fourthly, by loss in the heated gases and unconsumed air escaping through the chimney. Therefore, given the consumption of fuel per hour, then the generation of a certain number of units of heat in the fire-box becomes known. Of this a portion which is determinable passes through the fire-box surface into the water; the remainder goes to raise the temperature of the gases and the unconsumed air which enter the tubes at a temperature that can be estimated. The quantity of heat abstracted by the tube surface can also be ascertained, and the residue gives the temperature of the escaping gases lost through the chimney.

The results of his elaborate mathematical investigations are embodied in three formulæ:

$$\left.\begin{array}{r}\text{Evaporation from fire-box}\\ \text{in cubic feet per hour}\end{array}\right\} = \frac{S\,m\,x}{N} \qquad (a)$$

$$\text{Evaporation from tubes} = \frac{h\,x}{N}\left\{1 - \frac{1}{\varepsilon^{\frac{m\,s}{h}}}\right\} \qquad (b)$$

$$\text{Total from boiler} = \frac{x}{N}\left\{S\,m + h\left(1 - \frac{1}{\varepsilon^{\frac{m\,s}{h}}}\right)\right\} \qquad (c)$$

in which S = surface of fire-box in sq. ft.

s = surface of tubes (exterior) in sq. ft.

N = units of heat required to evaporate one cu. ft of water from 60° into steam at the temperature of water in boiler = 70,000 units.

x = temperature of gases in the fire-box before entering the tubes above the temperature of the water.

m = units of heat transmitted per hour through one sq. ft. of surface for each degree (F) of difference of temperature = to 11 units.

$\varepsilon = 2.718.$

$h = W\,G\,w\,\sigma.$ $\qquad (d)$

in which W = pounds of fuel consumed per hour per square

foot of grate; G = surface of fire-grate in square feet; w = weight of gases and unconsumed air arising from the combustion of one pound of fuel; and σ = specific heat of this mixture.

His method of investigation brought him to the following general conclusions, viz:

1st. That no fixed rule can be established as the best for the relative proportions for fire-grate, fire-box and tube surfaces.

2d. That length of tube has nothing to do with economic effect.

3d. That the diameter of the tube is also a matter of indifference.

4th. That the economy of fuel does not depend upon the rate of firing.

5th. That when the quantity of fuel burnt is moderate, say 50 or 60 pounds per square foot of grate per hour, the combustion is nearly perfect. On the other hand, with hard firing a considerable loss results from carbonic oxide passing away unconsumed.

6th That a large increase of heating surface in proportion to coal burnt only slightly increases the economical effect. In fact, within the limits of practice in locomotive engines, the economic effect is in proportion to about the fourth root of the heating surface.

O. Busse has analyzed the "Northern of France" experiments, more especially with the object of noting the influence on evaporation of the vacuum in the smoke-box. To throughly understand him, it may be as well to state that the experiments were carried out on a locomotive boiler with its barrel divided into four equal compartments by bulkheads, the blast being obtained from another boiler. It had 125 flues, 1.8 inches diameter inside and 12 feet long. The fire-box had 76.5 square feet of heating surface, and each tube compartment 179 square feet, or a total of 794 square feet. With compressed coal as fuel the evaporation in pounds of water per square meter of surface was as per following table:

Vacuum in smoke-box in inches of water.	Evaporation from fire-box.	Evaporation from compartments of barrel.			
		No. 1.	No. 2.	No. 3.	No. 4.
.78	252.7	57.6	26.8	14.3	8.8
1.56	300.0	82.0	44.2	23.1	15.8
2.34	410.5	118.1	48.4	38.7	25.5
3.12	460.9	105.1	55.0	34.7	25.3
3.9	417.3	149.8	68.4	46.4	30.1

Evidently there is some error in the figures, for 2.34 inches of vacuum and 3.12 inches; allowing for this M. Busse deduces the following empirical formulæ:

(I.) For the evaporation from the fire-box per square foot of heating surface per hour,

$$F = 100 \sqrt[3]{v} + 16 \sqrt{v} - 36,$$

where v is the vacuum in the smoke-box in centimeters (= 0.39 inches) of water.

(II.) For the evaporation from the tubes in any particular division of their length, per square foot of internal surface per hour,

$$S = \frac{25 + 32.4\,v}{(1.3 + 0.05\,v + e)^2},$$

where e is the distance of the centre of the division from the fire-box tube-plate, and v is the vacuum in centimeters, as before.

(III.) For the evaporation from the whole length l of the tubes,

$$R = \frac{25 + 32.4\,v}{(1.3 + 0.05\,v)(1.3 + 0.05\,v + l)}.$$

He considers the maximum efficiency may be calculated by taking a vacuum of 12 centimeters (4.72 inches), and finds this gives an evaporation of 0.16 cubic foot of water per square foot of total heating surface per hour, coinciding with the best Austrian railway practice. A very common and generally accepted figure is 0.13 cubic foot for ordinary conditions of locomotive working.

The foregoing table is of interest as showing how the blast pressure (the vacuum in smoke-box) improves the evaporation from the flues. Comparing the figures for .78 inch and 3.9 inches of vacuum, we find the latter increased the evaporation of the fire-box 65 per cent., of the first tube section 160 per cent., of the

second section 163 per cent., of the third section 224 per cent. and of the last section 242 per cent. Nevertheless, the flue surface is of such little value (comparatively speaking) that under the low vacuum it takes 29 square feet of tube surface in last section to do the duty of one square foot of fire-box, and even under the high vacuum the proportion is almost 14 to 1.

For most of the foregoing I am indebted to the proceedings of the Institute of Civil Engineers. J. DAVIS BARNETT.

Appendix B.

DESIGN OF LOCOMOTIVE BOILERS.

In this paper the writer proposes to briefly consider certain features of boiler design, which not only come within the consideration of the committee of which he is a member, but also that of the committee of which Mr. Hickey is chairman.

Believing, as he does, that a great improvement will result from an aggregation of small ones, he will not hesitate to suggest slight changes, many of which will have a familiar sound.

The matter of free steaming is undoubtedly much assisted by free circulation, and by way of accomplishing this, the use of wider water spaces would probably be advisable if the grate surface be not too much contracted thereby. The great difficulty which water must meet with in making its way to the bottom of water-legs must be detrimental to free steaming, and it has always seemed probable that a bottom water space under the grates, would assist in supplying new water to the side and back spaces, particularly if the forward water-leg is made unusually wide, say 6 inches. Boilers with this bottom space were built many years ago, but within a few years have been revived by Mr. F. W. Webb, London & Northwestern Railway. To still further assist in free circulation about the fire-box, where it is most needed, the inside sheets can be either carried up straight or slightly inclined inward, but flanged out near the tube sheet to accommodate a large number of tubes. The loss of crown-sheet area would, without much doubt, be compensated for by the gain in freedom of escape of the steam.

The space between tubes has always been a matter of specula-

tion, and it is well known that this space has sometimes been too small, and in fact probably always is so, or, at all events, never has been too great. In an ordinary locomotive boiler there can hardly be too many tubes, as long as gases escape at a higher temperature than the water.

The efficacy of circulating plates, in certain marine boilers thereby separating the upward from the downward currents, is so well established, that there can be no doubt that too much attention cannot be given to the subject of circulation.

There is a variation in practice in the angle of inclination of the rows of tubes, as seen when looking at the tube sheets. When this angle is 30° with a horizontal line, the path of escape of steam and water is less obstructed than when the angle is 60°. It would be very interesting to know whether anybody has noticed any difference in the efficiency of boilers with tubes inserted in these two ways.

No apology need be made here for reference to a patented boiler, but the writer's recent experience with the Strong boiler in competition with the ordinary, corroborates his opinion that a higher evaporative rate can be obtained from a boiler with a water space under the fire-box.

The free escape of steam can be further assisted by using the Belpaire fire-box instead of the round top type, as this presents a considerably larger steam liberating surface than the other form, as well as more steam room.

Closely allied with this matter is the method of taking the steam from the boiler, and I again hazard the opinion that water is far less likely to be picked up by moving steam if it is quietly drawn from all parts of a boiler than if drawn from one point; or, in other words, that it is far better to take steam through perforated pipes extending to or near the extremities of a boiler than from a dome. This is particularly true when an engine is working hard, and using all the steam that can be furnished. We are all familiar with the rapidity with which a gas-charged bottle of water will empty itself if the cork is quickly drawn, and this phenomenon undoubtedly occurs to some extent in a domed boiler, as witness the rapidity with which a too full boiler lowers its water when the safety valve pops.

There are so many hundreds of domeless boilers at work in different parts of the world that it cannot be regarded as experimental.

Now, with reference to the area of grates, there is no doubt in my mind that it is all but impossible in an ordinary locomotive to have too large a grate, particularly for a hard-working locomotive. If the grate is small the exhaust nozzle must be so small as to seriously disturb the fire and drop much unconsumed coal through the grate, and to carry much of it into and through the tubes. This is a great source of waste. Wherever a great quantity of coal is to be burnt, my observation has led me to believe that it can be best done with a thin fire. Wherever but little coal is burnt, it has been my observation in stationary practice that it can be accomplished with great economy with a fire two or three feet thick, although this is probably not advisable. If the fire is too thick when rapid combustion is to take place there is but little probability that sufficient air will be admitted to complete the combustion. I must here again refer to the Strong boiler, which I have seen so much recently, and will say that it is the most perfect soft coal burner that can be imagined, even when carelessly fired, largely because it has a large grate, and is of such a nature that a thick fire cannot be carried. The extravagant consumption of coal by some recent large locomotives on a New England railroad was probably due to improper firing, the fire which the writer saw having been fully 3 ft. thick.

The large grate will frequently cause a direct loss of heat on account of excessive blowing off at stations, or when steam is shut off; but this, in the case of some recent experiments carried out by the writer, was the least evil. The saving from the gentle blast far more than offset the loss of heat due to blowing off.

Now I take it that such considerations as these are embraced within the saving clause of D. K. Clark's oft-repeated saying that there cannot be too little grate area "so long as the required rate of combustion per square foot does not exceed the limits imposed by physical conditions."

Nor can the boiler as a whole be too large. Any thing that can diminish the forcing principle in American railroad practice will produce economical results, and a large boiler is an important means to this end.

Combustion chambers have not been touched upon by the committee, but they are without doubt a valuable feature in a locomotive boiler, because they give more time for the completion of combustion, if sufficient air has been admitted, either through or over the fire. This combustion should be completed before the gases enter the tubes, for once having gone so far there is little chance of their burning, as they are then rapidly cooled. Fortunately the brick arch in bituminous coal burning engines with deep fire-boxes accomplishes the end of a combustion chamber in a very perfect manner, and combined with a sufficiently large grate and proper admission of air becomes a good smoke consumer. If the combustion is complete before the gases enter the tubes, it makes but little difference whether the tubes are large or small, except in so far as the amount of the heating surface is affected thereby.

If the combustion is not complete before the gas enters the tubes, the larger the tubes the better.

Now, with reference to construction, the Belpaire appears to be the only logical form of the ordinary boiler, for the following reasons:

(*a*) It dispenses with crown bars which prevent circulation, free escape of steam and proper cleaning of the crown sheet.

(*b*) It is the only form in which the stresses can be accurately determined, and the parts properly proportioned to their duty.

(*c*) It does away with the springing and buckling of the outer shell which characterizes the round top boiler, whether the crown sheet is supported by crown bars or by direct, more or less radial stays.

(*d*) It is of such a nature that the pressure of the steam on the inner crown sheet is absorbed by that in the opposite direction upon the outer. Hence there is no tendency to force the inner fire-box out of the boiler. It thus diminishes transverse stress in the side stay-bolts, and does away with the necessity of double riveting the base ring.

(*e*) It is apparent from these considerations that it is safer than the usual forms.

(*f*) Other advantages, in regard to steam space and circulation, have been mentioned.

The advantages of butt joints for the longitudinal seams of boilers are very generally recognized, and it is safe to say that no other kind should be used. F. W. DEAN.

Appendix C.

The following circular of inquiry was sent out by the committee:

The questions refer to boilers using bituminous coal:

1. Have you, in renewing boiler tube plates, or in building a series of new boilers, altered the number or size of flues, or altered the clearance space between them, without altering the length of flue or altering any other part of the boiler or engine?

If so, can you give comparative results, either in fuel consumed for work done or in water evaporated, stating the exact change or variation you made which produced such results? This information should be given in answering any of the questions; and in quoting results, endeavor to distinguish between higher evaporative power ("free steaming") and increased economy in evaporation (more water boiled off per pound of fuel).

2. Have you made any such change, keeping the flue-heating surface the same in total amount, but putting in flues of larger diameter, so as to increase the gas opening through the flues; or made any such change, still keeping the flue heating surface the same, but putting in flues of smaller diameter, thus decreasing the gas opening through the flues?

3. Have you made any such changes, either shortening or lengthening the flues, but keeping the total flue-heating surface the same?

4. Do you know of any instance in which reducing the flue-heating surface, or reducing the gas opening through the flues, increased in any way the efficiency of the boiler?

5. Have you made any changes in the amount of grate surface without altering the boiler or engine at any other point? If so, with what result? If you have knowledge of any experiments of this kind carried out on other than locomotive boilers, kindly quote them also.

6. In designing or ordering locomotives, do you proportion the amount of grate surface simply to suit the quality of coal like-

ly to be used, or do you believe—if the boiler is to be in its most effective condition—that the grate surface should bear some definite proportion to the flue-heating surface; or to the gas opening through the flues? If you proportion, give the ratios you use or would like to use.

7. Is it possible, within the narrow limits of deviation allowed in an ordinary locomotive, to give a boiler too large a grate surface?

A grate may be too long for the firemen to equally cover it with coal, or it may have too much air opening through it to suit certain qualities of fuel; but these points are not properly to be taken into a consideration of the question of absolute grate surface.

8. If to use a certain quality of fuel you have found it necessary to put at one end of the grate a solid "dead plate," or "drop plate," has such reduction of the effective grate area lessened the evaporative power of the economical efficiency of the boiler? In answering question 8, a note should be made as to whether, in making the change, the clearance between the fire-bars (air space) was altered.

9. Have you in any way improved a boiler by reducing the total grate surface, all other points remaining unchanged?

10 Are you familiar with any experiments tending to show that rapid combustion is, for steam purposes, more economical than slow combustion? If so, quote or refer to them, and say if you think the result is due to the higher temperature (commonly believed to accompany rapid combustion) transmitting a larger portion of its heat through the metal or to a more thorough burning of the fuel?

This matter has a close bearing on the whole subject, for, other things being equal, the smaller the grate the more rapid is the combustion.

11. What is the present limit, in locomotive practice, to the number of pounds of good clean coal that can be fully burnt per hour per square foot of grate surface?

12. Are there any facts from which it may be reasonably inferred that this limit will in the near future be exceeded?

13. How many pounds of water (from and at 212 degrees) will

one pound of good coal evaporate when the grate is thus working up to its highest limit?

14. What is the minimum amount of flue surface per square foot of grate that will do this high duty?

J. DAVIS BARNETT.
F. W. DEAN.
PHILIP WALLIS.

On motion of Mr. Sprague the report of the committee was accepted.

MR. BARNETT—In explanation of the subject as assigned to your committee I would say, it is rather indefinite in its detail. We understood our duty to be to see if we could find out some arithmetical proportion between grate surface and flue heating area, that was best for given classes of engines. With that idea in mind, the inquiries were written and forwarded. The few replies received, and the tendency of conversation with members of this association, all go to show that such a proportion does not exist. No amount of investigation would show what would hold under different conditions of service and different fuel to be burnt. Each member of the committee proposed to add a little to the report; but for reasons quite satisfactory to the committee, Mr. Wallis was unable to do so; and therefore but two members of the committee contributed. The part contributed by the chairman covers a large amount of reading. It gives the results so far as he could find them of all known experiments showing the value of tube surface. When I say results, I rather mean the opinions formed by certain investigators, based on those results and the formulæ show how these opinions can best be used. If any engineer is designing a perfectly new boiler—that is varying from his ordinary practice, and he wishes to find out to what extent the proposed variation would influence evaporation, it would help to give him some idea of the probable amount of water he could evaporate from a given length of tube. I think the most important point in that particular appendix, is that showing the vast increase in the value and length of flues when the smoke box vacuum is largely increased. When that vacuum is low, when there is very little draught, the outer end of long flues has very little evaporative efficiency, and if you get up to four or five inches, then the efficiency of the forward or smoke box end of the flue is increased from 200 to 300 per cent. However, with equal areas, of course, even under those conditions, a square foot of flue surface at the forward end has only about 1-14 of the efficiency of a square foot of fire box surface.

MR. HICKEY—I see the report says that Mr. Schlacks states that he changed the dead plates from the back to the front. In the course of changing anything in the fire box, the fire brick should be considered. It makes a great difference whether that engine had a brick arch in or not. The very fact of changing that from the back to the front would give very different results with or without the brick arch. That is one of the points that ought to be explained. It is of no value unless you know all the particulars. It is apt to mislead you.

Again he says: "Mr. Allen Cooke gets from seven to nine pounds of water, Mr. Schlacks from 5½ to 6, and Mr. Ellis says he consumes 120 pounds with a heating surface of 74 to 1 of grate." Now in speaking of that we should know the coal that is used. It is the character of the coal that I have reference to, whether Hocking Valley or Illinois or whatever it might be. Perhaps Mr. Barnett will explain.

MR. BARNETT—Mr. Barnett has given all the information that Mr. Schlacks gave him. The inquiries were made with a certain object in view of combining the answers and getting at certain results. There were not enough answers sent to enable the committee to do so, but sooner than let the committee's work go by default altogether, the committee gave all the information the members of this association sent to it.

On motion of Mr. Ferguson the discussion was closed and the committee discharged.

NOMINATION OF OFFICERS.

SECRETARY SINCLAIR—I wish to submit the report of the committee on the nomination of officers if there is no objection.

THE PRESIDENT—There is no objection.

The Secretary read the following report:

"The Committee appointed to nominate officers report as follows: President, R. H. Briggs; 1st Vice President, John Mackenzie; 2nd Vice President, Albert Griggs; Secretary, Angus Sinclair; Treasurer, O. Stewart.

(Signed.) WILLIAM SWANSTON.
ALLEN COOKE.
JAMES M. BOON.
JOHN HICKEY.

On motion the report was received.

DISCUSSION ON FOUNDATION RINGS.

Mr. Lauder had not been present at the discussion of the report on Foundation rings, and on motion of Mr. Hickey the subject was re-opened for discussion.

THE PRESIDENT: The subject of fire box rings for locomotives is now open for discussion.

MR. LAUDER—In the report on the best form of foundation rings for locomotive boilers I feel somewhat interested, because I practically made the report. This matter of foundation rings for locomotives I consider a very important one, especially to the roads in portions of the country where the water is of an inferior quality. I am thoroughly convinced that the recommendations presented by the committee are worthy of careful consideration; that is that the mud-rings of the locomotive boiler should be of a little more substantial character than we have been in the habit of putting in. We should put in a ring, as

the committee have suggested, that is ample in depth to take two solid rows of rivets all the way around. I have used the double riveted mud ring for a number of years, but mind you it has always been where the water was good. Now what effect bad water would have on a foundation ring of the character that I have been using, solidly riveted with two rows of rivets, I am unable to say, except that I have corresponded quite largely with gentlemen who have used it in the west where the water is bad, and the results have been uniform; that is there has been absolutely no leaking or trouble in any way, whether the foundation ring has been fastened to the sheets or the sheets to the foundation ring by two rows of rivets. I want to say just one word in regard to the workmanship. The committee have suggested that it would probably be found by everybody to be economy to machine the ring possibly all around, but especially around the corners. Now I thoroughly believe that the expense of machining or slotting out the sides of the ring around the corners would be money thoroughly well spent, because a smooth clean surface would be very much easier to fit the plates to and get them to lie up solidly to the ring to make a good, thorough mechanical job than to do it in the ordinary way where the ring is as it comes from the blacksmith. The cost of upsetting the rings, and giving stock enough around the corners so that they can be machined up would be very slight. Every shop where they build boilers has of course vertical slotters, and to put that ring on to a slotter and machine around the corners is a very inexpensive job, and the results that we should get from the better workmanship would be very good. We have gone on for thirty or forty years and practically have made no improvement in the character of our foundation rings. We have apparently supposed that leakages about the bottom of the furnace, and especially at the corners, were something that we could not get over—something which the type of boiler we used made—I won't say necessary, but it was one of the defects of the locomotive type of boiler that they were bound to leak around the corners. Now I do not think that that is true. I believe that we can make just as tight and substantial work around the bottom of the furnace as we can around the dome. It is simply a matter of design and then good workmanship.

Another thing that the committee mentioned was the report that shallow fire boxes setting on top of the frame are coming into use very rapidly. I think this denotes a rapid change in our methods, that is coming into use all over the country. Now leaks in the mud ring, around the corners especially, you can readily see are a very annoying thing in that form of construction. You can not get at the plates or seams to caulk them; you can not get at them to do anything in fact without taking the boiler off the frame in many cases; and that of course is a job which no one wants to do. With a little more care and money put in in the first instance, I believe that the leaks which now annoy us can be prevented. In fact, I am certain of it, and it can be done by the method that the committee recommended.

MR. F. B. GRIFFITH—To me, this is a very important matter. We have got very bad water on some of our divisions. We have sulphuric acid to a large

extent, and we had a great deal of trouble with the corners of fire boxes. If this report advocates double riveting, let me ask why it is necessary to double rivet on the sides where there is never any leak? Now they must all be in the same situation that we are in, because they are all liable to leaks on the sides. But we do have a great deal of trouble in the corners, and it seems that the corners might be raised and have double riveting in there and single riveting along the sides, and still accomplish the desired end.

MR. J. N. LAUDER—In reply to the gentlemen I will admit that with good workmanship there ought not to be leakage except at the corners with a single row of rivets, but practically there is trouble at other points than the corners. It is due, of course, to poor workmanship. But where we have got to rely on locomotive builders largely, we will occasionally get that poor workmanship, and the liability of leakage where there is a double row of rivets is very much reduced from what it is when you have a single row. I admit that a single row of rivets will make tight work, except at the corners. I do not think it is possible to make it tight at the corners with a single row of rivets, but we are not always sure of getting work that will make it tight all around. I have been troubled out West, where the water is poor, with leakage all around, in work coming from builders. I think a ring made in that way and put into a furnace would cost as much, if not more, than it would to make it deep all around and with two rows of rivets. The two rows of rivets can not do any harm. They are a safeguard against a variety of things. I do not think it would cost any more and I can see no objection to it. There are other methods of strengthening the corners, of which the committee have furnished drawings and which they have discussed in their report. But I think either of those methods would be as expensive, and possibly more expensive, than the plain double riveted ring, and I do not think it would be as surely effective as the double riveted ring, and on the whole I can see no good reason why we should not carry the double row of rivets all the way around and make a good, substantial job, and it provides a safeguard against poor workmanship. Another thing which I believe will be found to be effective is this: A double riveted mud ring having a taper of 3½, 3¾ or 4 inches, as the case may be, makes the bottom of the furnace so much more solid and substantial that the tendency for the sheets—either the outside plate—or the inside, to groove at the top of the ring will be very much lessened. I thlnk I can see the reason for that. I do not know whether I could explain it; possibly my theory in regard to it is faulty, but what makes the grooving, of course, is a combination of mechanical and chemical action. There will be no grooving unless there is a moving of the plates. If there is a movement of the plates there will be grooving. The mechanical action of the movement of the plates tends to concentrate the movement at the weakest point, which, of course, will be immediately at the top of the ring or at the root of the seam. You will find it always at a seam; you never find grooving in the middle of a boiler. It is where the action, if there is any, is constant. That tends to keep the metal raw and allows the acid in the water to work there, and in a little while you have a groove. Now,

the action that produces that grooving is a bending motion of the inside fire box due largely to expansion—expansion and pressure together. Pressure has a tendency to force the inside box out. That produces a bending motion. The movement is concentrated at the ring. You will find a groove cut immediately along the ring at the outside plate. You can see that the bending motion keeps that raw. Now I think it is fair to assume that if you have a ring there 4 inches deep or 3½ inches deep—enough to get two rows of rivets, that it makes it more substantial—that there will be smaller tendency for it to bend and produce this movement that causes grooving, than if it was two inches thick and riveted with one row of rivets. I think that is worthy of consideration and I believe that part of that grooving which we very often find when the water is bad is due largely to the insubstantial condition of the boiler at the bottom of the furnace.

MR. HICKEY—I think the leakage of a foundation ring is largely due to an unequal and irregular expansion at that point, and when there are two rows of rivets it is a great help in obviating that trouble. There is less trouble, less leakage certainly on that account. I would like to ask Mr. Lauder if he is prepared to advocate a sheet running below the foundation ring and riveted on the inside, or if he has had any experience in that direction, and also whether he would advocate a sheet running around the corner; that is, the back sheet being doubled around the corner and running to the side sheet a short distance, taking thereby the seam away from the corner.

MR. LAUDER—As to the first proposition of extending the inside sheet of the fire box around the corners below the mud ring, far enough to get a single row of rivets through a flange running down from the ring—that has been done and is now largely used; in fact, you might almost say universally used in some parts of Europe. It is a very good form of construction, but I can see no advantages that it possesses over the system that the committee advocates and recommends. I think it would be found to be more expensive in its construction, although I am not sure about that. Mr. Mackenzie has used that form of fastening, and with a good deal of success. Mr. Brown, of the Canadian Pacific, who perhaps drew his inspiration largely from his experience in Europe, has also used that form, and I think is using it universally and with a great deal of success. But that simply makes a good corner. It does not help you anywhere except at the corners, and we do have trouble at other points than the corner, and especially by grooving. Now, whether the double riveted mud ring will entirely prevent this trouble of grooving I am unable to say, but I do believe that it will to a certain extent mitigate it. The form of construction that Mr. Hickey suggests, any one can see is a good one. It will make tight work at the corners, undoubtedly, if the workmanship is well done, but it is an expensive ring to make. You have got to have a flange welded to project below the leg proper far enough to get in a single row of rivets around each corner. I suppose that projection would necessarily have to be welded onto the ring. A bad welding might not develop until the engine was put into service, and it would be a disastrous thing in that case. On the whole, I be-

lieve that the form of construction which the committee advocates is the best, the simplest, the plainest, and ordinary workmanship can accomplish it. There is one objection I see to the form that Mr. Hickey suggests, and that is, when the boiler is placed on top of the frame, if it could be made so that the projection would project down inside of the frame, then you could get at the corner in case there should be a leak, and in that case it does not raise your boiler so much above your frame. It occurred to me that the form would be rather an annoyance, where the boilers are set on top of the frame; however, that is simply a mechanical difficulty that could easily be overcome, but it is to my mind an objection. And the other form—it is equally effective where the boiler is set on top of the frame as it would be where it goes between the frame.

MR. GRIFFITH—There is a little point there which is very interesting to me, and that is about this grooving. Mr. Lauder claims that the working of this ring, the bending of the sheet, is what gives the sulphuric acid an opportunity to eat the iron away. We have a great deal of trouble with that. It eats right through. But we do not have it at the throat of the fire box. We have it wherever a stay bolt has been driven or wherever there is a water bar put in in bad shape, and we have it all around the ring. I would like to ask those who have used double riveting if they have any grooving with it.

THE PRESIDENT--Are there any gentlemen who can answer Mr. Griffith's question?

MR. JOHN MACKENZIE—I do not get up to answer Mr. Griffith, because I have had no experience in double riveting, but I have had experience in this way--that a five-eighths rivet is not large enough. Now, if you will put a seven-eighths rivet in there, you will stop the leaking of your rings. A five-eighths rivet is so slim in the length of it that you can not upset the rivet properly where you drive it, and it simply bends and fills a hole in that direction. If you have got a rivet large enough to withstand the thrust of the hammer and upset it properly, you will draw your sheets up to the ring and they will be tight. Another thing is the very bad workmanship that is generally done on the corners of these rings. Whenever we remove a ring from an engine, we take it to a slotting machine and slot it inside and out, making it a smooth fit for the sheets. After that is done, the ring is taken into the boiler shop and the flue sheets and other sheets that go in there are set into their place hot. I do not see any necessity for double riveting at all. I think with a seven-eighths rivet, with the ring that you have got now, you will have your sheets tight. As to the corners business, I think I noticed that on the Kansas Pacific road fifteen years ago, and I think they are using it there yet with excellent results, carrying it back four rivets. There is no waste of material; it is simply throwing it up further and carrying the row of rivets 8 or 9 inches above the bottom ring. This method of dropping the corner down on the ring I think is an excellent one, because we are able to hold the outside sheet with a screw bolt; we get the benefit of having a rivet through both sheets and being perfectly tight.

Mr. Twombly, of the Rock Island road, has a great many engines with that on, I believe. I borrowed the idea from him. I think it is a good one.

MR. SPRAGUE—I realize the importance of this subject, but inasmuch as the members do not seem to be thoroughly conversant with it and our time is limited, I move that the discussion be closed, hoping in the future that members will be able to give more information about it when they learn more of it.

THE PRESIDENT—It is moved that the discussion of this be closed. I just want to say that, by a motion of Mr. Sinclair this morning, the regular order was varied and miscellaneous business taken up.

The motion to close the discussion was carried.

THE PRESIDENT—The next regular business in order is the report on water space surrounding fire boxes and flues. Is it usually large enough for free circulation?

Mr. Hickey will read the report.

Mr. Hickey read the following report:

REPORT OF COMMITTEE ON WATER SPACE SURROUNDING FIRE-BOX AND FLUES OF LOCOMOTIVES—IS IT USUALLY LARGE ENOUGH FOR FREE CIRCULATION?

Your Committee to whom was referred the above subject caused to be issued in the usual manner a circular of inquiry containing 11 questions, introducing the subject as follows:

The average amount of steam evaporated from a given amount of coal burned is usually in the ordinary locomotive boiler only about one-half of what a perfect utilization of the heating properties of the coal should accomplish. It is believed that much of this waste of heat is due to a restricted circulation of water in the boiler; that is, owing to inadequate passages for the water, the latter is unable, under certain conditions, to maintain its continuity with the heated sheets.

To the end that this subject be investigated, and that a report be made based on practical results, the undersigned Committee ask your kind attention and answers to the following questions.

Only 14 replies were received, viz:

From J. N. Lauder, Old Colony Railroad (A); W. A. Foster, Fall Brook Coal Co. (B); Francis R. F. Brown, Canadian Pacific (C); Matt Ellis, Chicago, St. Paul, Minneapolis & Omaha (D); W. C. Arp, Chicago, St. Louis & Pittsburgh (E); Wm. Garstang,

Chesapeake & Ohio (F); F. F. Tynan, of Cuba (G); Z. J. Ferguson, Mobile & Ohio (H); Allen Cooke, Chicago & Eastern Illinois (I); Geo. W. Stephens, Lake Shore & Michigan Southern (J); G. W. Rhodes, Chicago, Burlington & Quincy (K); T. W. Gentry, Richmond & Danville (L); F. Slater, Milwaukee, Lake Shore & Western (M), and J. S. McCrum, Kansas City, Fort Scott & Memphis (N).

To avoid a constant repetition of names when referring to the statements, they will be known by the bracketed letters following each name.

To the first question : "Do you think the water space usually allowed between inner and outer sheets of a locomotive fire-box sufficiently large to permit a free circulation of water in contact with the heated sheets, under circumstances of a high temperature in fire-box ?"

Eleven master mechanics say in substance; I do not consider the water space usually allowed sufficiently large for free circulation and while I have made no special experiment or tabulated statement to demonstrate the fact, I have arrived at this conclusion from a close observation of comparative results. A, B and D say : I have not observed any facts to lead me to believe that the water spaces surrounding the fire-box of the ordinary locomotive was insufficient.

To the question : "Have you made any experiments to demonstrate your conclusions ? If so, please state particulars."

Nine say they have made no experiments; E, G, H and N say they have increased the water space surrounding the fire-boxes from 2½ and 3 inches to 4 inches, with results of greater durability of fire-box sheets, and decidedly freer steaming engines.

To the query : "Can you suggest a means whereby a better circulation of water in the space surrounding the fire-box would be assured ?"

Six master mechanics answer "No," eight say increase the water space to four inches by all means even should it be found necessary to decrease the grate area to attain this point.

The fourth question : "If you suggest a change in shape of the fire-box sheets to accomplish the purpose, will such change interfere with the space in fire-box allotted for combustion ?"

Five pass this unanswered; two advise placing fire-box on top of frames to get the desired water space; one answers: "Make slab frames and get a wider fire-box," and six assert that the small reduction in fire-box necessary to obtain the desired increase of water space would not perceptibly decrease the efficiency of the combustion chamber.

To the fifth question: "What width of water space do you suggest as being sufficient between the inner and outer sheets of fire-box? Side. Back. Front."

E, G, I, L, M and N say: Side and back 4½ inches, front not less than 5 inches; B, C, F and D say: Sides and back 3½ inches, front 4 inches; A writes: "Three inches all around is sufficient."

To the question: "Do you consider the clearance space usually allowed between the boiler tubes of a locomotive sufficiently large to permit the highest evaporative power at that point under condition of the maximum heat in fire-box, and assuming the boiler tubes to be two inches outside diameter, what clearance space do you allow between them?"

D, F, G, I, J, K, M and N answer: Do not think space as usually allowed large enough, and suggest a clearance space of ¾ inch; E and H say the same, except they suggest a clearance space of ⅞ to 1 inch; A and B say ⅝ inch clearance is ample.

To the question: "Do you prefer placing boiler tubes in flue sheets in line vertically or situate them zigzag fashion?" "Please state your reasons for the preference."

B, C and F say zigzag fashion, because it admits of a larger number of flues thereby increasing the heating surfaces; all others are understood to say the vertical passages between tubes should be straight, not zigzag as is the usual custom.

To the question: "Do you favor the use of ordinary crown bars, placed in the usual manner for staying the roof sheet of fire-box?" "If not, please state objections."

A, G and I answer: "Yes," but qualify this assertion by saying that while it has bad features, it is the safest known method; B, C, F, D, H, K, L, M and N give a decided negative, adding in substance that this manner of staying causes a rapid accumulation of scale and mud, greatly impedes the circulation of water, thus

reducing the efficiency of that important heating surface, as well as tending to a rapid destruction of the crown sheet.

In answer to question: "Have you adopted a system of radial stays for crown sheet, or any method of staying said sheet differing from the old style crown bar? If so, please send the committee sketch showing the manner in which it is done."

K, L and N say they have adopted a system of radial stays for all new engines; eight say they have not yet adopted this system, but are thinking of doing so.

To the last question: "Do you favor the use of flat or circular crown sheets for locomotive fire-boxes, and which method do you regard the most efficient for transmitting heat?"

A, G and H prefer flat crown sheets; K uses the Belpaire type of boilers for all new engines, and with it a flat crown sheet. The flat sheet, he states, has many advantages, one being the full thread it permits in the shell for purpose of direct stays; it also admits of a larger volume of water at that point than a curved sheet. All others say they prefer a sheet slightly concave toward the fire, holding as a reason that this shape adds to its resisting power, and from its increased surface in contact with the water is more efficient in transmitting heat.

While many of the questions have been answered with the monosyllables "Yes" and "No," the majority have been replied to fully and earnestly, several members warmly discussing the subject in a general way, and all admitting the importance of the subject in hand.

Summarizing the answers as impartially as may be, your committee find there is almost an unanimous sentiment in favor of enlarging the water space between the inner and outer sheets of a locomotive fire-box. This feeling also prevails regarding the clearance space between the boiler tubes. It is generally admitted that where the feed water is largely or even moderately charged with foreign matter, the water space on the back and sides of the fire-box should not be less than 4½ inches, with a distance of not less than 5 inches between the front sheets of box, while a few advocate a water space surrounding fire-box of 5 inches.

The ordinary American type of locomotive boiler with deep

fire-box has usually been given but 3 inches water space between the side and back sheets. When replacing fire-boxes many have increased this to 4 and 4½ inches, and have obtained therefrom the most satisfactory results, both as to durability of fire sheets and augmented evaporation.

On this point Mr. Stevens, of the Lake Shore & Michigan Southern, writes: "It is our practice for engines in heavy express train service to use a water space around fire-box of 4 inches. For such engines, having extreme depth of fire-box, we believe this space is preferable to that of less width, as it permits a more free circulation of water, prolongs the life of the fire-box, and is conducive to free steaming; we, of course, recognize a loss of grate surface, but prefer this to a more restricted circulation." The same authority states: "Some years ago experiments were made on several of our express engines to ascertain if water in leg of fire-box at side sheets was in contact with said sheets when engine was working. The manner of determining this was by screwing a cock through outside sheet and allowing it to project into water space up to within about ½ inch of inside sheet of fire-box, a rod and handle reached to cab for the purpose of controlling this valve when the engine was in motion. It was found that at all times very little water would come from the cock, and, as a rule, when engine was working, the discharge would be what is termed by engineers, as seen from the gauge cocks, as 'steam and water,' usually more of the former than the latter."

The information received by your committee, particularly from locations where the feed water contains scale-producing elements, leads them to believe that the general feeling is there should be a clearance space of ¾ inch between two inch tubes in locomotive boilers, and that the spaces between should be in straight line vertically, the latter condition offering not only less hindrance to the circulation, but would be a great aid in precipitating the deposited matter.

Mr. McCrum, of the Kansas City, Fort Scott & Memphis, on this point writes: "I appreciate the advantages of a large heating surface, but, as regards increased flue heating surface, I am confident it is often obtained at the sacrifice of water space; com-

parative performances of boilers on this road with a greater and lesser number of tubes proving this."

The several expressions smack strongly of doing away with the old style crown bars and replacing that method of staying with some system offering less resistance to the circulation.

Mr. Francis R. F. Brown, of the Canadian Pacific, sends a blue print showing construction of boiler used on that road, concerning which he writes: "I do not think I can answer the various questions any better than by referring you to this drawing; it is our standard mogul engine boiler, forty of which we have in service on this road. The boiler is designed to carry 180 lbs. of steam, and I experience no trouble from any of them; I prefer the arrangement of tubes as shown on the drawing on account of less liability of the boiler mudding up. As to the arrangement of crown bars, I have found the combination as shown on the drawings to work very satisfactorily, having had several years' experience with them."

Your committee regret not having sufficient information at hand from which to compile a report based on comparative results, and the committee not having had time or opportunity to make the necessary tests feel that any further recount of the subject must be largely suggestive.

The serviceable period of a locomotive is dependent largely on the duration of its boiler. The limit of power is determined by the boiler; the generating power, the safety and the duration of a boiler, mainly depend on the facilities offered the water for reaching and remaining in contact with the heated surface. The efficiency of the heating surface is measured by the amount and frequency of the water in contact with it, therefore any effort tending to promote the freedom of, or hasten the action of the water towards the heating surface, or in any way encouraging its presence at the heated sheets, is one towards increasing the power, the efficiency and the duration of a locomotive.

The evaporation per pound of coal used, in a large majority of locomotive boilers, is far less than should reasonably be expected. This is undoubtedly owing in part to an insufficient supply of water in proximity to the fire sheets, caused by the narrow water spaces surrounding the fire-boxes, together with

the flues being set so closely together that the circulation of water among them is greatly impeded, thus reducing the efficiency of the heating surface. These conditions are further aggravated by the scale deposit on the transmitting surface, and this with the usual cumbrous manner of staying the crown sheet, hindering in consequence the circulation, thus impairing the efficiency of this sheet as a heat transmitter.

The results of improper circulation of water in a boiler is not confined to the loss of a reduced evaporation for a given amount of fuel used; to this is due the rapid deterioration of the fire-box plates caused by overheating. the pernicious effects of which are scarcely realized. When plates are overheated, the unequal expansion of the inner and outer sheets strain them to such an extent that frequent renewal of stay bolts becomes necessary; there is also danger that overheating may cause an expansion of the metal to a point in excess of its elastic limit, in which case, a permanent set must occur, and the metal is in precisely the same condition as though the limit of elasticity had been exceeded by overstrain.

May not in some cases, also, the heat in our fire-boxes be too high to produce steam ? In our early years we were taught that steam was a perfect non-conductor of heat, and for an illustration the rolling of a drop of water across the surface of a hot stove was cited ; by way of explanation we were told that the drop rested on a thin cushion of steam through which the heat could not penetrate so that the water was not warmed. Can not this same thing take place, only on a larger scale in a boiler where the circulation is impeded ?

The panacea for the evils enumerated is, plainly, larger water space and a thorough circulation of the water within the boiler, the principles of which are well known. To obtain this, however, that it may reach the full measure of requirements, is a question not so easily solved. That such is necessary in order to obtain the full heating value of the fuel used, is indisputable, and to reach that point will require more attention than has heretofore been given it, is also certain.

When we depend on the specific gravity of water to bring about a circulation necessary to absorb the heat generated in a

locomotive fire-box, large and unrestricted passages for its operation are essentially necessary. It is but waste to produce heat unless we have the means at hand to absorb it. In order to get any work or usfulness from heat it is necessary to have a hotter body and a colder one; it is therefore as necessary to produce the colder body as that the hotter one be generated.

Another point which involves a common mistake is the attempt to increase the amount of heating surface by putting in more tubes; this will not necessarily increase the steaming capacity; indeed, the reverse may take place, the crowded condition of the tubes retarding the circulation. The number of tubes on many locomotives can be reduced from 10 to 20 per cent. with decided advantage. It is true that this will reduce the heating surface, but in very many cases the increased efficiency of those remaining will more than compensate for the loss in number

Heating surface in the abstract is one thing, its capacity for transmitting heat is another. With a circulation not too restricted undoubtedly the most important parts of the heating surface are the fire-box sheets; this may include 12 inches of tube surface nearest the fire-box. A flat, horizontal surface, situated as the crown-sheet above the fire, or one at that point concave to the fire, is best adapted for receiving and transmitting heat, and from its situation in the boiler must facilitate the access of fresh supplies of water to replace the heated ascending particles, hence the necessity of freeing the crown-sheet of every possible attachment that might interfere with the free movement of water.

A surface sloping towards the fire is next in efficiency for transmitting heat; if it is proposed to enlarge the water-ways surrounding the fire-box, the space bordering the foundation ring need not, perhaps, be increased, as the water at that point receives but little heat. A tapering enlargement of the space in a vertical direction may be accomplished by sloping inwardly the side sheets of the furnace, thus increasing the heat imparting power of the surface, without perceptibly diminishing the efficiency of the combustion chamber; the sloping sides not only receive the rays of heat at a more favorable angle for transmission, but, on the

water-side, the heated particles have less difficulty in disengaging from the surface than if the sheets were strictly vertical.

The evaporative efficiency of a boiler depends, no doubt, to some extent, on the nature and thickness of material forming the heating surface. Carefully conducted experiments, some years since, however, and the results later of actual practice, show that, after the first few days of work with ordinary impure feed water, there is no perceptible difference in the evaporative power of copper, brass and iron tubes, although their relative conducting power, when clean, are, respectively, 74, 24, 12, and that, so far as the economical use of fuel is concerned, there is no gain in using the highest priced metal; it is remembered that the same result was found when using slightly different thicknesses. The difference between the steaming power of new boilers with furnace plates ⅜ and 5-16-inch thick was found to be materially in favor of the thin sheets; but it is asserted that this difference disappeared as the plates became coated with incrustation. It is a fact well known that furnace plates having a thickness of ⅜ and 7-16-inch are more liable to fracture than 5-16-inch plate, and this argument is at times used to prove the inferior evaporating power of thick plates; this, however, does not necessarily follow; the injury to thick plates is mostly caused by unequal expansion, this evil being directly proportional to its thickness. Considering the speed of the heated currents in a locomotive fire-box and the short time allowed for transmission, a homogeneous plate of absolutely uniform thickness, and about 5-16-inch thick, practically appears to be the best adapted to perform all duties required of the sides and back plates of a furnace.

Your committee have observed cases where a portion of the tube surface nearest the fire-box has been replaced by combustion chambers, reducing proportionately the area of water space of the boiler, and presenting a less amount of transmitting surface for the flame, but allowing a better mixture of the gases and a more perfect combustion, yet a loss of evaporative power, or at least no perceptible gain of the latter could be observed, showing that changes of this kind should be made with great care, and reminding one of the necessity of keeping constantly in mind that the correction of one evil may lead to the cause of another.

Your committee can not urge too strongly the necessity and importance of admitting the feed water regularly, and at the same time entering with an equal flow at pipes on opposite sides of the boilers. The inlet volume of the feed water is by this means divided, resulting in less variation of boiler temperature, effecting a more uniform expansion, and assisting largely the circulating action of the water.

It has come to the notice of your committee that mechanical means have been introduced for the purpose of enforcing a rapid circulation and equalization of water in a locomotive boiler. The principal features of the device, however, or what results have been obtained from its use, we have been unable to ascertain. Movements in this direction are worthy of the most serious consideration, and it is hoped that members knowing anything of such a contrivance, will state the matter before the convention.

It is desired, in conclusion, to say that, owing to circumstances beyond their control, the report does not contain as much information on the essential points of the subject as the committee intended. We entertain high hopes, however, that the suggestions herein will enable a future committee to promptly prepare and carefully make some experiments, which shall lead to early and valuable conclusions.

JOHN HICKEY,
J. N. BARR,
R. W. BUSHNELL,
Committee.

DISCUSSION ON WATER SPACE SURROUNDING FIRE BOXES.

On motion the report was received.

MR. HICKEY—I will say, gentlemen, that the committee desires to apologize to the convention for the disconnected construction of the report, but it is partly due to not receiving the necessary information to be embodied there. Indeed, after the report was placed in the hands of the secretary several communications were received but unfortunately the information there given was not embodied in the report. However, if it is desired, it can be annexed as an appendix to the report, but I do not think that is necessary. There is another point I want to mention: With a larger space between the inner and outer sheet of the fire-box, we get a longer stay-bolt and with a longer stay-bolt there is less liability to breakage.

THE PRESIDENT—Discussion of the subject is now in order.

MR. MACKENZIE—There is one part of this report upon which I do not agree with the committee, and that is making the sides of water spaces taper-

ing—larger at the top than at the bottom. I think that is a very bad thing. In washing off crown sheets, there are large scales that are removed and they drop down and wedge themselves if the water space is tapered. My practice would be to make the water space larger at the bottom than at the top, so that if scale started it would go down clear to the bottom. I have had many side sheets destroyed by reason of the scale being wedged in that way. I think if we want to make more water space we had better make it parallel. Whatever size we determine to make it I should make it as large at the bottom as at the top.

MR. HICKEY—We know that the efficiency of a boiler varies largely in its capacity for generating steam, and we know too, that we can not generate steam unless we have water. We also know that unless we have water in contact with the heating sheets, we can not generate steam. We also know that if the sheets are placed vertical and the space is contracted at the top, it retards the upward and downward currents. Mr. Mackenzie takes the point that the space should be smaller at the top, well, that may be good enough for getting rid of the scale, but it is a great hindrance to the evaporative power of the boiler, because that is the thing you have got to provide for—the upward and downward current, and with a sheet that is strictly vertical or leaning over, the currents have greater trouble in being disengaged; therefore a sheet that offers the greatest freedom to the upward and downward currents is the one to be used. You may get your space on top smaller, but it is certainly at the sacrifice of efficiency.

MR. LYNE—In reference to the shape of the space at the side of the fire box, I think that any of you can demonstrate that to your entire satisfaction by taking a test tube that is straight, half fill it with water and begin to boil that water, and you will find that it will be thrown out at once. You take a glass tube of a funnel shape or the shape of a Ven'uri tube, and place under it a spirit lamp, fill it two thirds full of water, if you please, and you will find the globule of steam when it is first formed is so small that you can hardly see it. As it rises to the surface it expands and it follows almost identically the size of the tube up, and escapes in the form of steam at the surface of the water. Now you can boil that water as hard as you please but you can not throw any of it out. In fact there have been boilers designed of that form, among which may be mentioned the Shepherd and the Malvin. There is very little water space above the surface, and you can drive those boilers to their full extent and yet get dry steam. The plea that the space at the top should be contracted to prevent large pieces of scale falling down, I think has no weight, from the fact that there are substances which can be used to prevent the formation of scale altogether. You can do it for instance by the circulation of water. Now I had an instance where the boiler could be run only about three months when it would be all clogged up with scale and I tried various compounds; some were bad and some were good. I ordered a barrel of the good compound and it did its work first rate. The second barrel did not do so well and I had to abandon it, in consequence of the varying quality of the compound. After experimenting with various substances I settled upon kerosene oil, and I ran that boiler six months without washing it out. The interior surface of those boilers was kept perfectly clean.

There was mud of course. I know an instance of vessels connected with the Pennsylvania Railroad in one of whose boilers they used kerosene oil, putting in ten gallons every week. The oil reaches every part of the boiler and they find no scale in the boiler at all. In other boats of the same line working under the same condition, it was found that between the tubes it was filled almost solid with scale—hard at that.

The engineer would not believe it when he was told it, but they took the tubes out and showed that that was the case. There are two conditions—one uses kerosene oil and the other uses nothing. The engineer of the boat that had the scale in told me the other day that he was going to use kerosene oil. I have no doubt he will find the same result as the other. I know hundreds of cases where kerosene oil has been used where there is sulphuric acid in the water, as there was in the case of the boiler I used, and I found that the use of kerosene oil prevented the corrosive action around the safety valve. There was a grooving which occurred in those boilers which was prevented. Now there are plenty of substances besides kerosene oil that will prevent this formation of scale, and the spaces should be proportioned so as to allow the free escape of the steam from the water, so that it can be disengaged, with the least possible friction, into the steam space.

MR. BLACKWELL—I think there is another point in favor of a wider water space near the top of the fire-box, which I think has not been touched upon, and that is the means of putting in longer stay bolts. Every one knows that the higher you get up on the box, the greater is the expansion, and the result is as everyone has found out to his cost, a number of broken stay-bolts near the front upper corner of the fire-box. Now having a wider water space in there enables you to use a longer stay-bolt, which will bend a greater number of times before it will break. I think that is a very important matter.

MR. MACKENZIE—That brings me down to this fact. That we never find a short stay-bolt broken in a fire-box. Now if it is necessary to have a long stay-bolt at the top to get the water space, why is it that the long ones always break and the short ones do not? My argument is simply this, that there is danger of distorting your side sheets by having the water space wider at the top than at the bottom. If you can afford to introduce water at that point where it is not required any more than it is below, at the sacrifice of your side sheets, then that is all right. But I do not think so. I have had several instances where side sheets have been burned out by the accumulation of large scales dropping off of the crown sheet. The circumstance was simply this—we had to wash off the crown sheets every time the boiler was washed, and the scale would be forced from the top of the crown sheet by the pump, and those large scales would drop down and lodge at different points, and the consequence would be that we would find the sheet burnt out. Now I hardly think that the long stay-bolt business is a good thing. I find a very good thing that we are doing on our engines, and that is zig-zagging the stay-bolts in between the others for the first four rows down from the top.

On motion of Mr. Peck, the discussion was closed.

APPOINTMENT OF COMMITTEE ON SUBJECTS.

THE PRESIDENT—Gentlemen, I will take this opportunity to appoint a committee to report subjects for the next annual meeting. That committee will consist of John Hickey, H. Tandy and W. Garstang.

The next subject in order is the report on the Magnetic Influence of Iron and Steel in Locomotives on the Watches of Engine Runners, which was read by the Secretary as follows:

REPORT OF COMMITTEE ON MAGNETIC INFLUENCE OF IRON AND STEEL IN LOCOMOTIVES ON THE WATCHES OF ENGINE RUNNERS.

Your Committee on magnetic influence of iron and steel in locomotives on the watches of engine runners submit the following:

As a large number of replies to the circulars issued by the committee last year failed to reach them in time to be embodied in the report which was submitted at our last convention, they have been received by the chairman of the committee appointed at the time the committee was continued, and together with the fact that much valuable information has been furnished by corresponding with master mechanics and others interested, your committee is enabled to submit a report based on the statements of some of the most intelligent and experienced engine runners, supported by the opinions of a number of master mechanics and other practical men.

We have gone carefully over and compared the statements and circulars, which were sent out by master mechanics to their engineers.

We have also carefully compared the letters of master mechanics which were furnished us when they sent the statements of engine runners; and after this careful digestion of all the matter on hand, which covers reports from nearly all the leading railroads, we find that the magnetic influence of iron and steel in locomotives, while it may affect the watch of runners to a very slight degree, that as a rule it does not amount to a serious disturbing element; and that if a watch is not exposed to any other more powerful electrical agent than the ordinary locomotive engine, no difficulty would be experienced in keeping accurate time-pieces.

We are satisfied, however, from our inquiries and from the answers to the questions propounded by the committee, that the

watches of locomotive runners are subjected to more rough usage than those carried by men in any other line of business; and that we frequently attribute to magnetic influence disturbances which are really occasioned by a sudden jar or jolt, or some one of the many little daily occurrences to which the watches of engine runners are subjected.

If it is very probable that more or less magnetic influence is brought to bear on the watches of locomotive runners from constant contact with iron and steel that would make them unreliable, it is desired, if possible, to entirely protect watches of locomotive runners from every element that has a tendency to interfere with perfect time keeping.

Your committee found that there is much more danger in magnetizing the watches of locomotive runners from contact with, or exposure to, the influence of powerful dynamos, magnets or currents such as may be met with in any large town or city at the present day—in the shape of electric light apparatus, electric motors and other electrical plant; and as many of our locomotive runners are of an inquiring disposition, and likely to be interested in machinery of all kinds, it is more necessary to try and protect watches from this cause than from any real danger in connection with the iron and steel in locomotives.

Your committee are fully convinced of the fact that the delicate parts of a watch can be easily magnetized if sufficiently exposed, and for this reason they think that the subject is worthy of very extensive consideration, as electricity in various forms is likely to enter even more prominently into the industries of this age than at present developed.

The subject of magnetic shields and protectors—if such things really exist—should be closely inquired into, and if it be practicable to absolutely protect or shield a watch from magnetic influence, inventors should be encouraged with this view.

Your committee can not recommend any system for bringing about this result, as the matter is somewhat in its infancy, and we merely desire to put ourselves on record as favoring a protection of the watches of locomotive runners and conductors from magnetic influence or other disturbing elements.

Your committee in going over the large number of statements

from locomotive runners, are convinced that much depends upon the handling of the watch and the care given it by the man in whose charge it is; and that an inferior time-piece in the hands of a careful man is sometimes more reliable than the finest watch in the hands of a runner who has no system in his method of winding, adjusting, etc. We mention this fact as having some bearing on the various causes of disturbances which the magnetic shield could not be expected to remedy.

Your committee desire to express their thanks to the gentlemen who so kindly favored them with information on the subject of protecting watches from magnetism, and while some of them are perhaps commercially interested, the fact need not prevent our extending to them the courtesies due to those who volunteer interesting, and we hope profitable, information on subjects under discussion by our association. All of which is respectfully submitted.

T. W. GENTRY,
JAMES MEEHAN,
HARVEY MIDDLETON, } Committee.

On motion the report was received.

DISCUSSION ON REPORT ON MAGNETISM OF WATCHES.

MR. LYNE—There is one point in connection with railway time-pieces that the committee seems to have overlooked. A railway time-piece, to measure accurate time, should have a very much quicker beat than watches used by ordinary individuals, for the reason that a quick beating time-piece will not be affected by the jarring or vibration to which it is subjected while in the pocket of the engineer or conductor. Now, the gist of the report here seems to be that the ordinary watch is good enough, provided it receives the proper care. In my opinion, in view of the fact that non-magnetic watches are made at an expense that does not really exceed that of an ordinary watch, it is best to have non-magnetic watches. For instance, I have in my pocket a watch that was made some years ago by one of the leading manufacturers, and by being in contact with dynamo machines and electric light apparatus, it used to get magnetized—not so that it would stop, but it would run very much slower than it ought to do. Of course, I removed that magnetism by subjecting it to the influence of a dynamo machine and revolving it in a direction opposite to that of the movement of the armature and gradually removed it from the magnetic field. But the same conditions which magnetized it at first will magnetize it again, so it was only a temporary relief. I sent the watch back to the manufacturers and had them put in a non-magnetic wheel and spring—a wheel in which there are no iron or steel parts. Now, any wheel which is made of a

magnetic metal like iron or steel, is liable to become magnetized, or be influenced by surrounding objects, or by the magnetic field of a dynamo machine. Now, I have placed that watch on top of a dynamo machine and it has been unaffected and has kept time straight along. It cost me ten dollars to have that change made. I understand that different manufacturers make those changes on watches of their own make. In my opinion, it is best to have non-magnetic watches in connection with railroads, because the cost is so little in advance of the regular manufactured watch, and they can be thoroughly depended on. I have my doubts as to a magnetic shield being so made as to thoroughly affect the parts of the watch so that they will not be magnetized. That is an open question at the present time.

MR. T. W. GENTRY—I do not understand that it was made the duty of the committee to inquire into the magnetization of watches, otherwise than in connection with the supposed magnetic influence upon watches of the iron and steel in a locomotive. The gist, of course, is not that we would recommend any ordinary time-piece, but simply that we fail to find, from any evidence that can be procured from any engineers of the best roads in this country, anything that would determine in our minds that you could magnetize a watch to any considerable extent by using it around locomotive engines. We simply made that remark in the report to show that a man might pay ten dollars for an apparatus the gentleman speaks of, and yet, by careless handling of the watch, destroy any good effect it might have.

Mr. JOHN T. SMITH—I have a watch here (showing it) that is 27 years old that has been four times around the world and was given to me by several gentlemen. It was a present during the war. That watch will run within a hundredth part of a second all the time; and you know, Mr. Setchel, that I have ridden on a lot of engines and cars have been near dynamos and all sorts of things, and when Smith is all right the watch is all right. (Laughter.)

Mr. GIBBS—It seems to me the subject would have been better put, if we had discussed the advisability of protecting the watches of engine runners against magnetism. There is scarcely more need of protecting against the influence of locomotives in that respect than of protecting one from snakes in Ireland. There is no magnetism, I believe, about a locomotive engine. But if your watch is already magnetized and has a constant rate of acceleration or retardation—mine has been accelerated—when you get on a locomotive engine, that is made irregular on account of the mutual influence of the magnetism in the watch and the mass of iron and steel in the locomotive. In view of the rapid increase of electric lighting and electric transmission of power, it seems advisable for us to consider whether it is necessary to protect the watches of engine runners in approaching machines of that character—not in going on their own locomotives.

SECRETARY SINCLAIR—Perhaps I can explain how this committee investigated this subject on the lines it did. Two years ago certain representations were made to this Association that there were strong magnetic influences developed in the iron and steel of locomotives through the pounding of service, just

as the striking of the end of a bar with a hammer has a tendency to magnetize it. The Association considered that it was desirable to investigate the subject, and it was that line that was under investigation, and the committee has followed the subject as it was brought before the Association.

On motion the discussion was closed.

SUBJECTS FOR INVESTIGATION.

THE PRESIDENT—The next business is the report of the committee on subjects for investigation and discussion. Is that committee ready to report?

The Secretary read the following report from the Committee on Subjects:

We beg to submit the following list of subjects for investigation and discussion at next convention:

1. Compound Locomotives. — Their relative efficiency as compared with simple engines. Is the saving in fuel large enough to compensate for the extra cost of compounding and the maintainance of increased number of parts? What are the proper proportions? Are the conditions of the American system of railroading such as to render compounding advisable?

2. Testing Laboratories, Chemical and Mechanical.—Are they desirable in connection with the mechanical departments of railways? Does a marked saving in expense, by insuring best material through chemical analysis, physical tests, result, etc.?

3. Link as compared with other valve motions.—Wilson's, Joy's, Walschaert's, etc. Has any device been found worthy to supersede the old style link for economical service on locomotives, all points considered, first cost, cost of maintainance, length of service, convenience, etc.

4. Aside from the increased grate area, are there any other advantages to be gained by placing fire boxes above the frames?

5. Steel vs. Iron Axles.—As relates to friction, wear of journals and journal bearing, liability to breakage in service.

6. Brick Arches in Locomotive Fire Boxes.—Best manner of applying them, their efficiency in consuming the various gases composing black smoke. The saving of fuel, when used in connection with extension of front end as compared with the diamond stack; first cost and cost of maintainance.

7. Locomotive Tanks and Tenders,—Best methods of preventing corrosion in coal space. Will it pay to shield the surface

exposed to coal; if so, what is the best material, and how should it be applied?

8. The best proportion of steam passages in relation to size of cylinders and steam pressure?

MR. BLACKWELL—I move, if it is in order, that the subject of the best shape or form of tender axle be included in the subjects.

SECRETARY SINCLAIR—I second that; for heavy tenders.

MR. BLACKWELL—Very well.

The motion as amended was carried.

MR. MACKENZIE—I have a subject here; what is the related value of large and small flues, and the length? I move that as a subject.

The motion was seconded.

MR. MACKENZIE—In looking over the question of compound engines, this engine that has been brought over from England has one feature about it that we have never been able to accomplish in this country, and that is throwing no black smoke. Now the flues in that engine are only an inch and a half in diameter by twelve feet long, I believe, and the heating surface is nothing like what some of our engines have, and the question arises in my mind whether the small flue has anything to do with the black smoke.

THE PRESIDENT—Those in favor of adding the subject suggested by Mr. Mackenzie will say aye—contrary no.

The motion was carried.

MR. LAUDER—There is one subject that has been agitating the mind of the railroad and mechanical world for the last few years, and it is a very important one, and it has been suggested by a good many of our members, and I think myself that this Association should appoint a committee to investigate the question and bring in a report at the next meeting. I think it is due to this Association to have some action taken on this subject, as it is something that we are very much interested in, and that is the subject that is now agitating the minds of our kindred organization, the Master Car Builders' Association —the subject of automatic couplers. It may, perhaps, seem that that subject is stale; but it seems to me that this Association should take a hand in this discussion of automatic car couplers. The tendencies of the times is to place the mechanical department of railroads under one head, and a large proportion of the members of the Association have to do with the car department—a great many of us are directly responsible for it, and I think it would be eminently proper for this Association to appoint a committee at this time to report to the next meeting on the subject of automatic car couplers. I would move that the subject be addded to the list just read.

The motion was seconded by Mr. Hickey.

MR. MACKENZIE—I do not think the subject, the way it reads there, should come before this convention. We are not Master Car Builders, and should not handle that thing; but if you make the motion read "for cars and tenders" we can handle it then without any trouble.

MR. LAUDER—I think that is a very good suggestion.

MR. HICKEY—While I have no objection to introducing the word tender, there is nothing in our constitution to prevent our saying cars only. If the gentlemen want to have tender included, I have no objection, but there is no reason why we should not name cars exclusively.

MR. LAUDER—I think it would be well to add "tender," because there are a great many Miller hooks used on the back of tenders, and a great many Jenney couplers. I think it would be well for us to have a report on that question. I have had automatic couplers on the rear end of my tenders and I have taken them off. Perhaps some others have used something different that would work satisfactorily. I think it would be well for that to be added. The committtee can just as well report on both as on one.

SECRETARY SINCLAIR—I should like Mr. Lauder to define to some extent the line of investigation he wishes to have followed, as I have considerable to do with getting out circulars and receiving replies to them, and I think it would be desirable to do that.

MR. LAUDER—Perhaps, Mr. President, it would be well to put it in this way—to report at the next annual convention the desirability of automatic car and tender couplers with reference to facilitating the interchange of cars, durability of the coupler appliances and safety to humanity. It seems to me that would cover the whole question.

MR. GIBBS—I would say that it would be a very graceful act if we could put ourselves on record as endorsing the action of the Master Car Builders' Convention in adopting an automatic coupler—endorsing it as a mechanical device.

THE PRESIDENT—You have heard Mr. Lauder's motion as a substitute for his previous motion appointing a committee on the subject of automatic car couplers.

The motion was carried.

MR. GRIFFITH—I would like to see a rising vote on this question. There seems to be quite an objection to it.

MR. SWANSTON—I would like to ask if this covers the whole field of automatic couplers, or if we are to stop with the adoption of a vertical plane coupler.

THE PRESIDENT—Nothing is said about that.

MR. SWANSTON—I understand that, but I would like to know if you are to open up the whole field. If you are, I would vote no.

MR. MACKENZIE—I rise to a point of order. The President did not state the question as Mr. Lauder put it.

THE PRESIDENT—The President stated it as the shorthand writer has it.

MR. GRIFFITH—I ask for a rising vote on this question, on the ground that it has been gone over thoroughly by the Master Car Builders and is settled, and I think if we want to put ourselves on record we ought to do it as a recommendation of their labors, and I call for a rising vote on the question.

THE PRESIDENT—That is not in order as there is no doubt about the vote at all. There were only two or three negative votes.

MR. MACKENZIE—I move that the whole question be re-considered.

The motion was seconded.

MR. LAPE—I rise to a point of order. Mr. Mackenzie voted in the negative. He can not move to re-consider.

THE PRESIDENT—The point is well taken.

MR. MACKINZIE—Mr. Gibbs brought up a question there that is well taken—that this association as an association should endorse the action of the Master Car Builders' Association in adopting automatic couplers for cars—the vertical plane type.

MR. GIBBS—Mr. President, I move to re-consider it on those lines.

THE PRESIDENT—How did the gentleman vote.

MR. GIBBS—I voted aye.

THE PRESIDENT—It has been moved and seconded that the question of automatic car couplers as amended to read car couplers, or car and tender couplers, be re-considered.

The motion to re-consider was carried.

MR. LAUDER—I call for a rising vote. I do not think the members really understood just how that motion was put. This motion as I understand it was for a re-consideration. Now if the motion was re-considered, then it brings the question up for another vote, doesn't it?

THE PRESIDENT—Yes sir. It stands as though the vote was not taken at all.

MR. LAUDER—Then I call for a rising vote, because I do not think anyone understood just what that meant.

MR. GIBBS—I move we amend the subject—that a committee be appointed to examine into the status of the automatic coupler question and advise whether the Master Mechanics' Association can endorse the action of the Master Car Builders' Association in recommending a type as standard.

MR. LAUDER—I see no objection to accepting that as a substitute.

The Secretary read Mr. Gibbs' resolution which had been reduced by him to writing, as follows:

"That a committee be appointed to advise the Master Mechanics' Association of the status of the automatic coupler question, and whether they can endorse the Master Car Builders' Association's action in recommending the vertical type as a standard, from a mechanical point of view."

On motion the subject was recommended for investigation.

ANSWERING OF CIRCULARS.

SECRETARY SINCLAIR—While this motion is being got ready I would like to make a few remarks about the answering of circulars. This is a subject that is before the association all the year. Of late there has been an impression among a great many of the members that the answering of circulars is of no

consequence. There are a great many subjects that are brought up upon which it is of the utmost importance that the individual views of all the members should be received by the association, and it is certainly the duty of every man who calls himself a member to give an answer to those circulars when they are sent to him, and the thing is allowed to go by default here regularly, the parties throwing these circulars aside and not answering them, and they do nothing that is creditable to themselves in doing so, and the interests of the association require that the practice should be greatly changed.

MR. HICKEY—I offer the following resolution :

Resolved, That it is the duty of every member of this Association who may be actually engaged in railway service, to answer all circulars of inquiry issued by committees of investigation at a date not later than May 1st of each year, and should they not be able to render the asked for information, or any part of it, they should at least acknowledge to the chairman of such committee the receipt of such circular. [Applause.]

The resolution was seconded by Mr. Blackwell.

SECRETARY SINCLAIR—Mr. President, I call for a rising vote on that resolution. [Laughter.]

The resolution was adopted unanimously by a rising vote.

THE PRESIDENT—The regular business is the discussion of questions to be submitted by members. The Secretary will read the first question.

RELATIVE PROPORTIONS OF CYLINDERS AND STACK DIAMETERS.

SECRETARY SINCLAIR—The next subject handed in is the relative proportions of cylinders and stack diameters. This was handed to me by Mr. Hickey. Perhaps he can name the party who suggested it. If not, I would suggest that Mr. Noble open this subject. He has had some peculiar experience lately with stacks, and has been investigating the subject of the best diameter.

THE PRESIDENT—Is the gentleman who proposed the question present? If not, will any member open the discussion?

MR. L. C. NOBLE—For the past two years I have been making some experiments in order to get the largest nozzle possible, and in making evaporative tests on fuel to get best results from bituminous coal. I started in by reducing the stack area and enlarging the nozzles. I first did it by reducing the straight pipe of the diamond stack on the 16-inch engines. I got it down to 12, and I have been running the engines for the past 12 months in both diamond and straight stacks with reduced diameter of stack. The 18-inch cylinder engines have 14-inch stack with 5-inch nozzles, and we are getting an evaporation of 7.25 to one, on a 16-inch engine with a 4¼-inch nozzle.

MR. MACKENZIE—What size nozzle do you use on a 16-inch cylinder?

MR. NOBLE—4¼; 12-inch stack at the base, 16 inches at the top.

MR. T. W. GENTRY—I would state that our experience has been somewhat in keeping with Mr. Noble's. We use a cast iron stack in connection with our extended front. We have very few diamond stacks. We have been reducing

the diameter of those stacks right straight along. We are now using the stack on 18-inch passenger engines with good result. A great many of the members are familiar with the cast iron stack that I speak of, it has been published and written up quite generally.

MR. MACKENZIE—I think that this subject, when members are speaking of it, should be whether this stack is used with an extension front or not. I did not understand Mr. Noble to say that it is used with an extension front.

MR. NOBLE—I have them both ways, the extension front, using 3½ mesh of No. 13 wire. The coal that we are using gives about 12 per cent. poorer results than we get from Westmoreland coal, and about 8 per cent. less than the Birmingham coal.

MR. W. MONTGOMERY—We have been making some experiments with stacks and nozzles, both with anthracite and bituminous coal, and in one instance we reduced the size of the stack and increased the nozzle with good results, by putting into practical operation the theory which was advanced by Mr. Webb, of placing a so called torpedo, a sort of cone-shaped casting near the base of the stack, with the idea of spreading the steam as it ascended from the exhaust pipe, producing a more perfect vacuum. Acting upon that idea I made a new exhaust pipe, and cast the centre down some distance and screwed into that a ¾ rod, and at the top of it screwed on the cone-shaped casting, so that the point of it entered into the nozzle, which was beveled out to throw the steam in such a form that it would strike the bottom of the stack and produce a vacuum, or expel the air the whole length of the stack. Where we were running 16-inch engines with 3½, 3⅝ and 3¼ nozzles, we found that we got 4¼, or nearly equal to a 4¼ nozzle by putting in this attachment. And the effect on the fire produced much better and more perfect combustion. Fewer sparks were thrown into the front end, and on the anthracite coal burners a more perfect fire was burnt. All over the fire boxes the draught was steadier and lighter, and although we have made no experiments as to the evaporation of water or the amount of coal consumed, the engineers in every case have assured us that they found a decided advantage in the running of the engine with the increased nozzle, and that there was also a less consumption of coal. On some engines we found that the fire was burnt more in front of the fire-box or more in the back. This, with the old diamond stack, we could adjust by raising or lowering the petticoat pipe; but in this case the draught plates, if properly adjusted, regulated the draft, so that an equal amount of air was drawn in through the grates and properly and evenly distributed all over the fire.

MR. MACKENZIE—I would like to hear from Mr. Murphy, of the New York, Lake Erie & Western, if he is in the room. I understand that they are using the stack over there, but perhaps Mr. Harrington can tell us the same thing.

MR. HARRINGTON—We are using on the Erie Road a cast iron stack, one size for all engines, about 15-inches at the smallest diameter and about 23-inches at the top, and it is nearly a fac-simile of that used by the Richmond and Danville. The weight of the stack is about 400 pounds and the base about

200, and the whole stack, fitted up and everything, costs about 12 dollars. For economy we think it is the cheapest stack that has ever been in use on the Erie. We have put that same stack on to some engines, some with 14-inch cylinders, some with 8-inch and many with 10, and some as high as 20, and get better results. Whereas I think the practice always has been in proportion to the bore of the cylinder so is the proportion of the diameter of the stack, and I think the Erie has found out that that is a somewhat false idea. We have one stack with good results on all classes of engines.

MR. MACKENZIE—I am glad to hear Mr. Harrington give us his experience in that matter. It seems to me that if that is the case the stack has not anything to do with the question. They use the same stack on the 14-inch cylinder as they do on the 22-inch. One boiler being, say 40 inches in diameter, and the other 60, if a 16-inch stack will empty a 60 inch smoke arch, why the stack on the 14-inch cylinder is too large. I do not understand how they get the good result that they claim they get there. They say that they save fuel and that the engines steam better. There is no question but that the engines do steam better. But what I am surprised at is, how the stack is going to do this business when the same diameter can be used on a 14 inch cylinder as on a 22-inch cylinder.

MR. NOBLE—I would like to ask Mr. Harrington what size nozzle he uses in his 17 and 18-inch engine.

MR. HARRINGTON—They vary of course. We do not say we have the same stack and same size nozzle. We have a 3⅛ in the 17x24, and we have them up as high as a 4-inch.

MR. NOBLE—I am running as high as a 3½ on a 14-inch cylinder engine.

MR. HARRINGTON—We do not know anything about what the exact diameter should be. We know that this is all right, but whether it ought to be 14⅝ or 15$\frac{1}{16}$ or something of the kind, I am not able to say.

MR. WEST, New York, Lake Erie & Western—We have been putting the same stacks on all classes of engines on the Eastern Division and we can save a ton of coal in 88 miles—on bituminous coal—with a 20-inch cylinder, using the same size stack that we use on the 14-inch.

MR. WILSON—I see that Mr. Stewart of the Fitchburg Road has just come in here. He has not heard this discussion. He and I had a conversation with regard to the relative diameter of the cylinder and the smoke stack the other evening. He has been making a series of what I think are very important experiments, but he did not find that any diameter of stack would go with any size of engine, and I never understood it in that way before, and it will be something that hardly meets my views of the case. I think that an engine with a 14-inch cylinder ought to have a little different sized stack from an engine with a 22-inch cylinder.

MR. STEWART, Fitchburg—The subject of relative sizes of cylinder and smoke stack I know is rather a delicate subject. On our road we have engines from 12-inches up to 20 inches cylinder diameter. A few months ago I was talking with one of my brother master mechanics. I asked him what sized

smoke-stack he used on his engines? He said 16 inches inside diameter. Was that on everything? Yes. Well, now, I knew he had substantially the same kind of engines that we did. In conversation with Mr. Boon, of the West Shore, I asked what sized smoke-stack he used; 13⅛ inches he said. Was it on everything? Yes. It worked admirably, he said, no trouble with the steaming of his engines. But previous to this I had made some experiments with a size of stack for different sized cylinder engine. It is a well known fact that the draught on the fire, depends on the vacuum you make in the smoke-arch. Now, then, we must have that vacuum in order to create a draught on the fire. The question that suggested itself to me was this—whether I would make the vacuum with a small exhaust pipe or whether I would make it with a small smoke-stack. To satisfy myself that there was something in it, I took a small engine that was running on the pay car. It had a 14x24 cylinder and was running with a 15½ inch stack. One car, of course, is not much of a load for an engine, but as a pay car is a thing that has to go pretty lively, at times they lacked steam where they wanted it. So I took that engine and put into it a 13-inch stack. The engine made one trip. The next trip that she made I enlarged the exhaust nozzles from 2¾ to 2⅞. It made plenty of steam and ran a great deal freer. The next trip it made I put about 3-inches. Now those are facts. Whether that has any particular bearing on heavier freight engines or not is another question to be considered. Then I took an 18x24 cylinder engine that had always been a poor steamer, when she was dropped below 6-inches. On 6-inches she always had plenty of steam. Drop her into 8-inches on a hill and the pointer would go one way all the time—nothing would prevent it—and that was not the right way. I took that engine and put a 13½ stack into it. I did not enlarge the exhaust pipe at all. I left it just as it was, but there was great improvement. With these things before me as having been tried on our own road, I came to the conclusion that it did make a difference whether an engine had a 16-inch stack, or whether it had a 13-inch stack with the same size of exhaust pipe.

MR. HARRINGTON—I would like to ask Mr. Stewart if that was a straight stack?

MR. STEWART—In both cases, yes, sir.

MR HARRINGTON—We could not do that. We could not accomplish what we did if we used a straight stack. I thought all the members were acquainted with the Richmond and Danville stack. It is very wide at the top and very narrow at the base, that is, where the stack joins the base, and widens off again to where it joins the smoke box. That stack, I think, can be traced to English practice. But that is the kind of stack we use on the Erie, and that is the kind of stack we get good results from. I think it would be absurd for us to attempt to put a 14-inch straight stack on an engine that has a 20-inch cylinder.

MR. GRIFFITH—I would like to ask the gentlemen of the Erie if they experienced any trouble with fire-throwing with the stack they are using?

MR. WEST—I can say no. All our smoke stacks that we have applied are without the extension, and our engineers say they are cleaner than the engines

running with the extension smoke stack. We run with both hard and soft coal. That is the universal testimony. There is no brick arch—no bricks connected with this thing.

Mr. Griffith spoke at some length on the locomotives belonging to the Erie not being free from spark-throwing.

MR. HARRINGTON—I want to say this much, that Mr. West could have gone a little further in his remarks when he said that we have engines without extension fronts. One would understand that we have engines without extension fronts, but with a spark arrester in. I think the stack in this case was without a spark arrester. I would like to ask him if he investigated and found out whether there was a spark arrester?

MR. WEST—There could not possibly be any spark to get out of our front end. A spark that could go through a 3½ x 3½ mesh is the only thing that could get out of our smoke stack.

MR MACKENZIE—Mr. West is a man after my own heart. I have been looking for somebody who could get along without an extension front and use a straight stack. Any straight stack is cleaner than a diamond stack. But the thing is this—it may be cleaner for the engineer, but is it better for the country at large? A year or so ago we got a lot of new engines on the road, and Mr. Hickey, in his address before our convention at St. Paul, induced me to put on that front end of his. I did so, and I used the stack that he recommended, which I think was reduced to 13½ inches. It is 20 inches where the casting is, and then runs up to 13½ and then expands, I think, two inches—something like that. Shortly after we got those engines, we had the misfortune to have one of them turn over and destroy the stack. We did not have any patterns of the stack, so we have to put on a straight stack. I put on an 18-inch stack, and I have been waiting ever since for the engineer to tell me the difference between those two stacks. I can not find out any. But if a man will tell me that he can run the old front end with a straight stack and not throw fire, he has got a wonderful engine

MR. JAMES MCBETH West Shore—As Mr. Griffith has been going through a number of experiments with the short front end and the straight stack lately, I would like to have him give some information to the convention here, just to let us know what he has been doing.

MR. LAUDER—I have been very much interested and somewhat amused, to hear the discussion that has been going on in regard to smoke stacks. It has of course drifted somewhat from the main subject, which is the proper diameter of stacks and the proportion of cylinder. But I think the discussion very wisely included the smoke arch and the exhaust nozzles and other things. Now I suppose that it is thoroughly well understood that we put on the long smoke arch for a spark catcher. It is simply a reservoir put on to the ordinary smoke arch to deposit sparks in and hold them there, until such time as we can get some place where we can discharge them without any annoyance to anybody. Now, as long as locomotives have a boiler, we must have a forced draught in order to get steam enough to do the work. That probably will always obtain.

because we have to carry our boiler around with us, and necessarily must have a very strong, compact boiler. The consequence is, we have to force the fire; that is done with the exhaust steam. Just as long as that fire is forced with the exhaust in order to get steam, just so long particles of unconsumed fuel will be drawn through the tubes. That is something you might as well make up your mind we can not get over. We can mitigate it to some extent by larger boilers. We can not go a great way further in that direction. We can mitigate it to a certain extent by a judicious arrangement of brick arch in the furnace and proper admission of air. We can mitigate the smoke nuisance by admitting air over the fire. That is an old device; but just to the extent that you admit air over the fire, just to that extent do you reduce your steam capacity, as a rule. But to go back to the question of sparks. These sparks, which are some of them unconsumed fuel, some dirt, various products of combustion, are drawn through the tubes. No matter whether a man says his engine runs clean or not, the fact remains that there is a lot of stuff that has to be drawn through the tubes that is unconsumed, and that stuff has either got to be discharged into the atmosphere through the top of the stack, or it has to be provided with some proper receptacle and held until you get to some place where you can deposit it without annoyance to anyone. Now the smoke arch is simply one of the forms of the old sub-treasury, which some of the members remember away back in 1850. Sparks were deflected by a suitable deflector in the top of the stack and passed down the tubes into this sub-treasury, as it was then called. The long smoke arch is simply a longer sub-treasury. That extension is simply for one purpose, that is, for a spark reservoir. Some of my good friends running a long extension smoke arch, pride themselves a little on the fact that they can run an engine a long distance, making a good day's work, and find no sparks in their smoke arch at the end of the trip. Now if I found that and considered that that was the best way, I should take that long smoke arch out. It makes great extra weight on the front end and produces hot boxes and all that sort of thing. If it is not going to be used for its legitimate purpose, take it out and do as the Erie road is doing, run a straight stack with nettings to obstruct the sparks to some extent. I believe the Erie road and every road that is running a straight stack on a short smoke arch is throwing sparks out. It is of no use for any man to stand up here and tell me that they do not draw these things through the flues. I do not know anything about what the appliances are on the Erie road. We are not criticising their management or their appliances, but there can not, in my mind, be a clean running engine with a short smoke arch and a straight stack. The sparks are ground up somehow, and thrown out so that there is no danger of fire. But a great many will be deposited on the train and will be an annoyance, at least to the passengers. That has been my observation for a great many years, and the more I see of it the more I am confirmed in my conclusions, that a straight stack on a short smoke arch, no reservoir being provided for accumulating these sparks, will throw more or less on the back of the train. I will admit that they can be made to run safely, because they do; but to make a clean running engine, to

make the train clean and eliminate the spark nuisance and prevent it from annoying the passengers, I do not believe can be done with a straight stack which throws up on the train all the products of draught and combustion that are drawn out of the flues.

MR. STINARD—I recollect reading some time ago the account of a trial down in New England. They had one of the New England Master Mechanics on the stand. During the trial the question was asked the master mechanic, who was on the witness stand, if there was anything that would entirely prevent an engine from throwing sparks? He said yes. Being asked what he would do, he answered: "I would not put any coal in the fire box." Now this question of an engine doing well and not throwing any fire, I do not believe in. I never saw an engine yet but what would throw fire.

MR. GENTRY—I do not want to reflect on anything that these gentlemen have said, but we have given a great deal of attention to this subject on our road. I am merely going to speak for the benefit of members from our experience. We have tried to make a short front, run clean and not throw fire. We have not succeeded yet. We are equipping all our engines—all old ones that are worth going over, and all newly built with an extended front, and we simply use it, as Mr. Lauder has said, as a receptacle for sparks; because we found w th the straight front that those sparks had either to be thrown out or they filled up the smoke box. We have good firemen burning coal for a number of years, we have good coal and I can show very practical data. I can show an engine there now which has been set aside. It was an old one. It had a crude apparatus for trying to run clean with a short front, and we have never succeeded, and I do not understand how it is that anybody else can do it, simply because we have done everything that can suggest itself to practical men. My experience is, you can not put an ordinary straight stack on a short front with any possible spark arrester, that will allow that engine to make steam and keep her from throwing fire. If she makes steam she will throw fire. The moment you get an apparatus that will arrest all sparks, then you will not get any steam. We certainly would not go to the expense and labor of making that front if we did not think from practice it was the best. I certainly am surprised to hear any gentleman state that he had succeeded, for I have worked for about seven years at it.

MR. MACKENZIE—I move that the discussion be closed.

The motion was seconded and carried.

METHOD OF SECURING FALSE VALVE SEATS.

SECRETARY SINCLAIR—The next question is: "Is it necessary to secure false valve seats to cylinders when balanced valves are used?"

MR. MACKENZIE—One of our division master mechanics called my attention to this subject not very long ago, saying that he had trouble with the false valve seats when he put the strips on his valve. I asked him what it was. He said that the valve seat lifted off its seat when the engine was reversed.

We have since put in four brass screws, one in each corner, simply to keep it from moving. That is all we have done in the matter. Perhaps some of the members may have had some experience and can tell us what caused it

MR. J. S. MCCRUM—In regard to the question as whether it is necessary to use a false seat I would say that I am using a balanced valve with false valve seats, and I have put in the false seats without securing them, and I have better success with them in all cases, than I did where screws were used to secure them.

MR. WILLIAM SWANSTON—We have used the false seat with a balanced valve and without it. We have no trouble whatever with the balanced valve so far. I think we have some 5 or 6 engines with false seats without anything to secure them. In one or two instances, without the balanced valve, we had the seat pop up and break. To obviate that I drilled a couple of holes and put in pins, one in each corner, just above the valve, allowing perhaps $\frac{1}{32}$ of an inch clear, at the same time leaving the seat free. I think it is a much better device than to fasten it on.

MR. MACKINZIE—Of course I understand that it has a great deal to do with how much of the valve is balanced. You can not hold a seat to the chest with a balanced valve that is properly balanced, because it will rise if the engine is reversed. If the valve is only partially balanced, you will retain weight enough there to hold it down perhaps to counteract the vacuum formed in the cylinders when the engine is reversed; but with us we have tried to take all the weight off the valves that we possibly could do, and we find that the seats will rise.

On motion the discussion was closed.

REPORT OF AUDITING COMMITTEE.

THE PRESIDENT—The report ot the Auditing Committee is in order.

The Secretary read the report of the Auditing Committee, which was to the effect that the books of the Secretary and Treasurer had been examined and were found correct.

On motion the report was accepted.

ROUTINE BUSINESS.

THE PRESIDENT—The next business in order is the reading of papers and the discussion of questions. A letter has been received from J. M. Toucey of the New York Central and Hudson River Railroad, which will be read by the Secretary.

The Secretary read a letter from Mr. Toucey inviting the members and their friends to an excursion to Toronto on the following day.

On motion the invitation was accepted.

SECRETARY SINCLAIR—I move that a committee on resolutions be appointed.

The motion was carried.

THE PRESIDENT—I will appoint on that committee Mr. Harrington, Mr. Lyne and Mr. Gibbs. They will please get together as soon as they can conveniently and get up a report. The next business in order is routine and miscellaneous business—anything that any member may have to bring before the association.

DISCUSSION ON METHODS OF CONDUCTING THE BUSINESS OF CONVENTIONS.

MR. WILSON—There is one thing that was spoken of here by the Vice-President that, I think, ought to be done in this association next year—that is have those reports prepared before-hand and distributed, and not have them read in regular meeting. There is also another thing you ought to have here, and that is a good sized black-board, so that a man, if he wants to say anything, does not need to say that it pops up, or something of that kind, but can go right up to the black-board and illustrate it so that all the members can understand it. I would say that in the Mechanical Engineers' Society they do that, and there are several of them here who have been talking this thing over, and they do not see that the business gets along quite so well as it does with them. I hardly think it does on that account.

THE PRESIDENT—I think that Mr. Wilson has been misinformed, as I have always heard the contrary report that the Master Mechanics' Association did its business in the most orderly manner of any Association of the kind in the country, and I believe that is the case. (Applause.) There is very good reason why the matter of printing reports and handing them out two or three days in advance has always been avoided in the Master Mechanics' Association, and that is this—when they are given out in that way not only are a good many of them lost and destroyed, but the papers get into print often before they are read, and sometimes when they are not read at all in the Association. That is the reason, Mr. Wilson, that that has not been done.

MR. MACKENZIE—Mr. President, I hope you will continue to read the reports. I think it is the proper way.

SECRETARY SINCLAIR—Mr. President, I am a member of both Associations, and I am considerably interested in facilitating the business of this association, and I have considered that matter, and I do not think it would be good for the interests of this association to drop the practice of reading papers. There are some parts, such as tables, which could sometimes be dropped to advantage, but, in the meetings of the Mechanical Engineers' Society, there are a great many members who know nothing about the papers that are under discussion. The papers are handed to members, but to a great extent they are not read, and this practice of handing them around to the members here in the meeting, and giving them the papers to make notes on, if they should find anything necessary for discussion, and then reading the paper, is, in my view, a much more preferable way to that followed in several of the other societies.

VOTING ON NEXT PLACE OF MEETING.

THE PRESIDENT—Gentlemen, the next business in order is the report of your committee on the next place of meeting. The Secretary will read the report

Secretary Sinclair read the following report:

"Your committee on next place of meeting reports on Chattanooga; Buffalo, Denver, Old Point Comfort, and Montreal."

THE PRESIDENT—These places are to be voted for by ballot. One of the three having the highest number of votes has to be selected within six months by the executive committee as the next place of meeting, and so you will please vote accordingly.

MR. L. C. NOBLE—My recollection is that last year the majority of our association wanted to go to Montreal. They expressed themselves in that way, and there was an expression from the association which showed that a large majority preferred to go to Montreal. Now I think it is due to the association when there is an expression of an opinion of that kind that the place preferred should be selected, and I think it due to the members to know why the committee of last year did not select Montreal. I know I asked last year, and I think there are a great many others who don't know why we did not go there, and I think they should know.

THE PRESIDENT—Can anybody give that information?

MR. MACKENZIE—I think Mr. Sinclair could explain that matter better than anybody else. Every member who was addressed on that matter by Mr. Sinclair had a preference for this place, I believe. We could not go to Chautauqua Lake for the reason that they could not accommodate us, or the accommodation was such as would not be acceptable. As you all know, a majority of the members who were at Alexandria Bay last year went to Montreal by boat and for that reason they did not care to go there again this year.

MR. NOBLE—That is not the explanation the Secretary gave me, and I would like to have the Secretary explain to the rest of the members just why we did not go to Montreal.

SECRETARY SINCLAIR—We did not go to Montreal because the members of the executive committee voted that we should go to Niagara Falls. (Laughter.) There is one part of the explanation, however, that I gave to Mr. Noble that I do not know whether it is altogether right to make public. The members of the executive committee know what it is, and if they think it is desirable to state it I will do so.

MR. MACKENZIE—I do not think it is.

MR. PECK—No, I do not think so.

THE PRESIDENT—I think, gentlemen, this inquiry had better not be pursued any further.

A MEMBER—I would like to know if the objection to Montreal would hold good at the present time.

SECRETARY SINCLAIR—No.

THE PRESIDENT—Gentlemen, I would appoint as tellers Mr. Barnett and Mr. Lewis.

MR. J. N. LAUDER, Old Colony—I have written my preference on that piece of paper, and I am asked by one of the tellers to put three names on my ballot.

THE PRESIDENT—That is according to the constitution, Mr. Lauder.

MR. LAUDER—That is I can vote for the same place three times?

THE PRESIDENT—Three places are to be voted for according to the constitution, and one of the three highest is to be selected within three months by the executive committee.

MR. LAUDER—I think that this ballot before it goes any further should be made plain. I do not understand the constitution to mean that at all. It certainly was not the intention of either of the framers to have anything of the sort. I will read, if you will give me permission, the article :

" Places for holding the annual convention may be proposed at any regular meeting of the association."

That has been done.

" Before the final adjournment the places proposed shall be submitted to a vote of the members, and within six months thereafter the executive committee shall select a place from the three which have received the highest number of votes."

Now if every man here votes for Chattanooga the executive committee have no option, but if they give one vote for Old Point Comfort, ten for Chattanooga and twelve for Buffalo, there are those three places to choose from.

THE PRESIDENT—The Chair will have to decide against Mr. Lauder. If Chattanooga should receive twenty votes and Montreal should receive eighteen votes and Buffalo should receive two votes, and there should be no other votes, those three would be the places that we would be bound to select from, notwithstanding that the place selected should be Buffalo which had only two votes.

MR. LAUDER—I see no difference of opinion between the Chairman and myself. It is a question of how we shall vote. I am going to vote for one. I expect my neighbor is going to vote for his preference, and when the votes are counted the three places having the highest number of votes will be the constitutional places from which to select our place of meeting. I do not understand that the constitution requires us to vote for only our single preference. I think the President is laboring under a little misapprehension in regard to the wording of the constitution. I agree with him thoroughly that the executive committee have a right to select either one of the three having the highest number of votes. For instance, if there are only three places voted for,—Chattanooga, Buffalo and Montreal, and Montreal has one vote, Chattanooga eighty and Buffalo six, the executive committee have a right to select Buffalo or Montreal or Chattanooga. But if there are four places voted for, they may only select from the three having the highest number of votes. I can see that there might be a hitch through two places having the same number. If that should happen we should have to put it to a vote again. But the plain wording of the constitution to my mind is that each man shall express his preference, and if there are three places, or six or ten

voted for, the three having the highest number shall be the constitutional places.

THE PRESIDENT—I think Mr. Lauder is correct in his position that you are required to vote only for one. My impression at first was that we could vote for three. I think now however that we should vote for only one place.

MR. MACKENZIE—We have had some trouble when only one place has been selected, in getting proper accommodation and proper arrangements for the members. Now the proposition was this, that the Executive Committee, having the authority to select the place of meeting, could do so, making the best possible arrangement. Now, if the convention sees fit to select Chattanooga or any other one place, I can not see what the executive committee can do. They will simply go there—that is all.

MR. BARNETT—The Scrutineers beg to report that the ballot for place of meeting shows as follows: Chattanooga twenty-nine; Buffalo twelve; Montreal eight; Denver six; Old Point Comfort four. The three heading the list therefore are Chattanooga, Buffalo and Montreal.

THE PRESIDENT—One of the places to be selected as the next annual meeting then will be one of those three. It may be Montreal, Buffalo or Chattanooga.

SALARY OF SECRETARY.

MR. JOHN HICKEY—I beg leave to offer the following:

Resolved, That the salary of the secretary of this association be set at $1,200 per annum, unless otherwise ordered by this association.

MR. LAUDER—I move that the resolution be adopted.

The resolution was adopted.

THE PRESIDENT—Is the report of the committee on resolutions ready?

L. R. POMEROY ELECTED ASSOCIATE MEMBER.

SECRETARY SINCLAIR—I have not received the report. I have received an application for associate membership which was received by the executive committee and passed unanimously. It is as follows:

"We respectfully recommend that Mr. L. R. Pomeroy, draftsman and treasurer of the Suburban Rapid Transit Company of New York, be admitted as an associate member."

MR. LAUDER—I believe, under the constitution, applications of that kind have to be submitted to the association by ballot.

THE PRESIDENT—What is needed is a motion to get it before the association.

MR. LAUDER—I move that we proceed to ballot for the candidate.

The motion was carried.

MR. BRIGGS—I move that the Secretary be authorized to cast the vote of the Association.

THE PRESIDENT—That is out of order, Mr. Briggs.

Mr. Barnett reported that fifty-two ballots had been cast unanimously in favor of the election of Mr. Pomeroy as an associate member.

THE PRESIDENT—The votes being unanimous for Mr. Pomeroy, he is duly elected associate member. Gentlemen, the next business in order is the election of officers. You will prepare your ballots to vote for President.

ELECTION OF OFFICERS.

The convention proceeded to ballot for President, and the result was announced by Mr. Barnett to be as follows: Mr. Briggs, thirty-one; Mr. Setchel, eleven; Mr. Mackenzie, seven; Mr. Griggs, one; Mr. Lauder, one.

THE PRESIDENT—Gentlemen, You have heard the report of your committee. Mr. Briggs having received the majority of votes cast, is declared duly elected President of the Association for the next ensuing year.

MR. BRIGGS—Gentlemen, to say that I thank you, very feebly expresses my feelings. That I consider it an honor to be President of this Association, I assure you is a fact. Having been born and raised in the State of New York, and having in boyhood seen cars propelled by horse power, which are now carried over the continent by the most powerful machinery in the world, and knowing that the locomotive of to-day emanated from the brains of such men as surround me, I feel proud that I am President of this Association. It is the representative association of one of the greatest branches of industry in the world, and as your President I will use every effort to cause it to be respected as such, and I ask that co-operation which I feel assured you will grant me in the performance of my duty as President. [Applause.]

THE PRESIDENT—Gentlemen, you will prepare your ballots for the office of first Vice-President.

MR. PECK—I make a motion that the Secretary cast the ballots of the convention for Mr. Mackenzie as first Vice-President.

The motion was carried.

THE PRESIDENT—Mr. Mackenzie, you are duly elected first Vice-President of this Association.

MR. MACKENZIE—I suppose it is in order for me to say something, Mr. President.

A MEMBER—Make a speech or tell a story.

MR. MACKENZIE—I will tell you a story, although I am not much of a hand at telling one. As the old Irish woman said when she asked her daughter: "Mary Ann, how long has Dinnis been waiting on you?" "I don't know," says the daughter, "I think about siven or eight years" Then she says, "Don't you think it is about time he was talkin' to you?" I don't fall into the mistake made by Dinnis. As Mr. Briggs has very well said, the man who is put in the chair of this organization certainly ought to be very proud. But I do not think that I can talk very well, and I guess I will just say that I am very much obliged to you for the honor, and I will endeavor to perform my duties to the best of my ability and in assisting our President in doing his work. [Applause.]

MR. PRESIDENT—You will prepare your ballots for the office of second Vice-President.

The balloting for second Vice-President resulted as follows: Mr. Griggs, twenty-seven; Mr. Hickey, eight; Mr. G. W. Stevens, seven; Mr. McCrum, four; Mr. Lauder, two; Mr. Gentry, two; Mr. Meehan, one; Mr. J. Wilson, one.

THE PRESIDENT—Mr. Griggs, having received a majority of all the votes cast, is duly elected second Vice-President of this Association. [Applause.]

THE PRESIDENT—You will prepare your ballots for the office of Treasurer.

MR. MACKENZIE—If I am in order I move that the Secretary be instructed to cast the ballot of the Association for Mr. O. Stewart for Treasurer of the Association for the ensuing year.

The motion was carried.

THE PRESIDENT—It is so ordered. Mr. Stewart is duly elected Treasurer of this Association.

MR. STINARD—I move that the same course be taken in regard to the Secretaryship—the President to cast the vote.

The motion was carried.

THE PRESIDENT—Mr. Sinclair, I have the pleasure of casting the vote of this Association for your re-election to the office of Secretary. [Applause. Calls of Speech from Sinclair.]

SECRETARY SINCLAIR—Mr. President and gentlemen, I thank you very cordially for the honor you have done me in electing me to this office. I am very proud of being Secretary of the American Railway Master Mechanics' Association. I do not know any position in the gift of the people of America that I would like much better to have. I think this is an organization which an officer has a right to be proud of. It is an organization that has always held a high name, and its importance seems to be growing every year. I have no doubt but that we shall be a very happy family of officers together, and the only request I have to make now is, that the members give me their co-operation by keeping me posted about their addresses and sending in answers to circulars promptly, and getting in the reports in good season so that I shall not have to wrestle too much with the printers before getting the printed copies out for the next meeting. [Applause.]

THE PRESIDENT—Is the committee on resolutions ready to report? While we are wating for that committee, is there any member who has anything to offer for the good of the Association?

THANKS TO PRESIDENT SETCHEL.

MR. BRIGGS—Before going home, and inasmuch as our President will go out of office to-day, I think that we ought to furnish some fitting testimony showing our gratitude to him for the services he has rendered this Association ever since its inception. When I look back over the reports of this Association, which I am fortunate enough to have bound, the idea occurs to me in almost every report that I read, that Setchel was there, that he was the life of the Association, by placing that report before us in the form in which we have

it, and I can assure you, gentlemen, that, being the one who is to follow in his footsteps, I think we can not do too much to show in some way that we consider that he has not only honored us, but that he has honored the American people by acting as the Secretary and President of this Association. Therefore I offer this resolution :

Resolved, That the thanks of this Association be tendered to Mr. J. H. Setchel for the very efficient manner in which he has filled the President's chair with honor and credit to himself as well as to the Association.

Mr. LAUDER—I move the adoption of the resolution just read.

Mr. BRIGGS—It is moved and seconded, gentlemen, that the resolution be adopted. All in favor of it will make it known by rising to their feet.

The resolution was adopted unanimously by a rising vote.

On motion of Mr. Briggs three hearty cheers were given for Mr. J. H. Setchel.

THE PRESIDENT—Gentlemen, I am very much affected by this action of yours, and I can only say that I am very grateful to you, and that hereafter I shall occupy a position that I have desired to occupy very much for many years, and when my friend Lauder and my friend Mackenzie and others of the leading spirits have these things all their own way, I shall be with them—I shall be on the floor, and I may not have so easy a time sometimes—that is all. [Applause.]

Secretary Sinclair read the report of the Committee on Resolutions as follows:

Your committee on resolutions beg leave to submit the following:

Resolved, That our sincere thanks are due and are hereby tendered to the Rev. C. S. Stowitts, and to President Sheldon, of Niagara Village, for their very cordial welcome of our organization ; to the various individuals and firms who, by their personal attention and financial aid, have helped to make this convention in every way pleasing and profitable and very grateful. We particularly appreciate the musical and literary entertainment furnished to us at the International Hotel; also the excursion on the lake by the Rotary Snow Shovel Company. We also desire to thank General Superintendent Toucey, of the New York Central & Hudson River Railroad, for the excursion tendered to Toronto; and to the proprietors of the *Northwestern Railroader* for the enterprise they have displayed in publishing daily reports of our proceedings. Respectfully submitted,

F. H. HARRINGTON.
LEWIS F. LYNE.
GEORGE GIBBS.

On motion the resolutions were adopted unanimously. The convention then adjourned *sine die*.

OBITUARY.

WILLIAM H. MORROW.

William H. Morrow died of throat consumption in Philadelphia, Penn., on February 19th, 1888, about 49 years of age. Mr. Morrow served in the Anderson Cavalry during the War of the Rebellion, and on his discharge entered the service of the Pennsylvania Railroad Company at Newport Station. He was transferred to Altoona as assistant shop clerk of Altoona shops about 1865, and in 1867 was made chief clerk to the superintendent of motive power, Mr. R. E. Ricker. When Mr. Ricker left the Pennsylvania Railroad to take the general superintendency of the Central Railroad of New Jersey, Mr. Morrow accompanied him, and served as chief clerk to Mr. Ricker at Elizabeth until about 1870. He was then forced to resign on account of ill health, and after resting for some months was offered an engagement with the Baldwin Locomotive Works, first as chief timekeeper, then as chief clerk in the drawing room, and afterwards was put in charge of the extra work department of the business. From this he was made assistant superintendent and then shop manager, and eventually admitted as a member of the firm January 1st, 1886. In all his business relations all his numerous friends admit that he was a true man. He leaves a wife and three children. For the Committee:

Wm. L. Austin.

GEORGE C. WATROUS.

George C. Watrous, a member of this association, late Superintendent of Motive Power and Rolling Stock of the Detroit, Lansing & Northern and Saginaw Valley & St. Louis Railroads, was born in Perry, Wyoming County, N. Y., June 12, 1831, and died at Ionia, Mich, June 6, 1889.

Mr. Watrous came with his father's family to Marshall, Mich., in 1842. In April, 1851, he entered the service of the Michigan Central Railroad Company in their shops at Detroit, as an apprentice. From 1854 to 1863 he was employed as a locomotive engineer on the Michigan Central Railroad, and after that time was for several years foreman in charge of the engines on the same road at Marshall.

He became Master Mechanic and Master Car Builder on the Fort Wayne, Muncie & Cincinnati Railroad at Fort Wayne, Ind., in 1871, and worked for that company in that capacity up to 1875. During the year 1875 Mr. Watrous became Master Mechanic of the Detroit, Lansing & Lake Michigan Railroad, now known as the Detroit, Lansing & Northern Railroad. A few years afterwards he assumed a similar position on the Chicago & West Michigan Railroad, and during the year 1885 he was appointed Superintendent of Motive Power and Rolling Stock on the combined roads, and held this position at the time of his death.

The deceased was a member of the Masonic Lodge at Marshall, and the Ancient Order of United Workmen, and Royal Arcanum of Ionia; and the kindness of the members of the different orders during his long sickness testify to the high esteem in which he was held, and nothing was left undone by the officials and employes of both railroads with which he was officially connected that could be done for his personal comfort, and to lighten the burdens and lessen the grief of those nearest and dearest to

him. His presence will be missed at our meetings, and his death will be mourned by his friends. The members of the Railway Master Mechanics' Association tender their respective sympathies to the widow and children who survive him.

CHARLES E. SMART,
S. D. BRADLEY,
THOS. J. HATSWELL, } Committee.

S. W. HAINES.

Samuel W. Haines was born in the town of Somerset, Pa., in the year 1851. At the age of 18 he went to work as an apprentice in the shops of the B. & O. R. R. Co. at Connellsville, Pa., learning the machinist's trade. After learning his trade he remained with the B. & O. R. R. Co. until the building of the P. & L. E. R. R., in 1878; during this time he served as General Foreman of the B. & O. shops at Pittsburgh, and afterwards at Connellsville, Pa. In the year 1878 (during the construction of the road) he became an employe of the P. & L. E. R. R. Co., holding the position of an engineer of a construction train. When the road was opened for traffic in February, 1879, Mr. Haines was appointed Master Mechanic and Master Car Builder, with headquarters at Pittsburgh, Pa. He held the positions of Master Mechanic and Master Car Builder of the above company until November, 1887, when, owing to ill health, he requested a leave of absence to recuperate; but he never again regained his health, and died January 22, 1889, of Bright's disease, in the 38th year of his age. He was twice married, having six children by his first wife, four of whom survive him, as does also his second wife. At Boston, in 1886, he first identified himself with the American Railway Master Mechanics' Association.

Mr. Haines was a genial, pleasant gentleman, and was universally esteemed by those with whom he was associated during his busy life.

L. H. Turner,
Wm. Flahaven, } Committee.
E. Richardson,

CONSTITUTION AND BY-LAWS,

AS ESTABLISHED BY THE TWENTY-FIRST ANNUAL CONVENTION.

ARTICLE I.

NAME.

The name of this Association shall be the AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATON.

ARTICLE II.

OBJECTS OF ASSOCIATION.

The objects of this Association shall be the advancement of knowledge concerning the principles, construction, repair and service of the rolling-stock of railroads, by discussions in common, the exchange of information, and investigations and reports of the experience of its members; and to provide an organization through which the members may agree upon such joint action as may be required to give the greatest efficiency to the equipment of railroads which is entrusted to their care.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The following persons may become active members of the Association, on being recommended by two members in good standing, signing an application for membership and agreement to conform to the requirements of the constitution and by-laws, or authorizing the Secretary to sign the constitution for them.

(1.) Those above the rank of general foreman, having charge of the design, construction or repair of railway rolling-stock.

(2.) General foremen, if their names are presented by their superior officers.

(3.) Two representatives from each locomotive building works.

Sec. 2. Civil and mechanical engineers, or other persons having such a knowledge of science or practical experience in matters pertaining to the construction of rolling-stock as would be of especial value to the Association or railroad companies, may become associate members on being recommended by three active members. The names of such candidates shall then be referred to the executive committee, and on a unanimous report from that committee in favor of their election the names of such candidates shall be submitted to ballot at any regular meeting and five dissenting votes shall reject. The number of associate members shall not exceed twenty, and they shall be entitled to all the privileges of active members, excepting that of voting.

Sec. 3. All members of the Association excepting as hereafter provided, shall be subject to the payment of such annual dues as it may be necessary to assess for the purpose of defraying the expenses of the Association, provided that no assessment shall exceed five dollars a year.

Such dues shall be payable when the amount thereof is announced by the President, at each annual meeting. Any member who shall be two years in arrears for annual dues, shall be notified of the fact, and if the arrears are not paid within three months after such notification, his name shall be taken from the roll and he be duly notified of the same by the Secretary.

Sec. 4. Any person who has been or may be duly qualified as a member of this Association will remain such until his resignation is voluntarily tendered, or he becomes disqualified by the terms of this constitution.

Sec. 5. Members of the Association who have been in good standing for not less than five years, and who through age or other cause cease to be actively engaged in the mechanical department of railway service, may, upon the unanimous vote of the members present at an annual meeting, be elected Honorary Members. The dues of Honorary members shall be remitted, and they shall have all the privileges of acting members, except that of voting.

Sec. 6. Any member who, during the meetings of the Association, shall be guilty of dishonorable conduct which is disgraceful to a railroad officer and a member of the Association, or shall refuse to obey the chairman when called to order, may be expelled by a two-thirds affirmative vote at any regular meeting of the Association held within one year from the date of the offense.

ARTICLE IV.

OFFICERS.

Sec. 1. The officers of the Association shall be a President, a First Vice-President, a Second Vice-President, a Treasurer and a Secretary, and they shall constitute the Executive Committee.

ARTICLE V.

DUTIES OF OFFICERS.

Sec. 1. It shall be the duty of the President to preside at all the meetings of the Association, appoint all committees designating the chairman, and approve all bills against the Association for payment by the treasurer.

Sec. 2. It shall be the duty of the Vice-Presidents, according to rank to perform the duties of the President in his absence from the meetings of the Association.

Sec. 3. In case of the absence of both President and Vice-Presidents, the members present shall elect a President pro tempore.

Sec. 4. It shall be the duty of the Secretary to keep a full and correct record of all transactions at the meetings of the Association; to keep a record of the names and places of residence of all members, and the name of the railway they each represent; to receive and keep an account of all money paid to the Association and deliver the same to the treasurer, taking his receipt for the amount; to receive from the treasurer all paid bills, giving him a receipted statement of the same.

Sec. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association; to receive all bills and pay the same, after having the approval of the President; to deliver all paid bills to the Secretary at the close of each meeting, taking a receipted statement of the same and to

keep an accurate book account of all transactions pertaining to his office.

ARTICLE VI.

EXECUTIVE COMMITTEE.

Sec. 1. The Executive Committee shall exercise a general supervision over the interests and affairs of the Association, recommend the amount of the annual assessment, to call, to prepare for, and to conduct, general conventions, and to make all necessary purchases, expenditures and contracts required to conduct the current business of the Association, but shall have no power to make the Association liable for any debt to an amount beyond that which at the time of contracting the same shall be in the Treasurer's hands in cash, and not subject to prior liabilities. All expenditures for special purposes shall only be made by appropriations acted upon by the Association at a regular meeting.

BOSTON FUND.

Sec. 2. The Executive Committee shall be a Board of Trustees having the care of the Boston fund. They shall appoint its custodian and give directions as to the investment of both its principal and interest; but they shall have no power to expend any portion of the fund unless authorized by a majority of the members present at an annual meeting and then only after due notice in writing, of a motion to expend such money has been given at the preceding annual meeting. A report of the state of this fund shall be made at each annual meeting, by the Executive Committee.

Sec. 3. The Executive Committee shall receive, examine and approve before public reading, all communications, papers and reports on all mechanical and scientific matters; they shall decide what portion of the reports, papers and drawing shall be submitted to each convention and what portion shall be printed in the Annual Report.

Sec. 4. Three members shall constitute a quorum for the transaction of business.

ARTICLE VII.

ELECTION OF OFFICERS.

Sec. 1. The officers of the Association shall be elected by

ballot separately at the regular meeting of the Association held in June of each year. A majority of all votes cast shall be necessary to an election and elections shall not be postponed.

Sec. 2. Two tellers shall be appointed by the President to conduct the election and report the result.

ARTICLE VIII.

COMMITTEES.

Sec. 1. At the first session of the annual meeting, the President shall appoint a Nominating Committee of five members, who are not officers of the Association, and this committee shall send the names of nominees for offices of the Association to fill vacancies for the ensuing year to the Secretary before the election of officers is in order, and they shall be announced by him as soon as received. The election shall not be held until the day after such announcement, excepting by unanimous consent. Any three other members may nominate candidates for any office.

AUDITING COMMITTEE.

Sec. 2. At the first session of each annual meeting an Auditing Committee, consisting of three members not officers of the Association, to be nominated by any member who does not hold office, shall be elected in the same way as officers are voted for. This Auditing Committee shall examine the accounts and vouchers of the Treasurer and certify whether they have been found correct or not. After the performance of this duty they shall be discharged by the acceptance of their report by the Association.

COMMITTEE ON SUBJECTS FOR INVESTIGATION AND DISCUSSION.

Sec. 3. At each annual meeting the President shall appoint a committee whose duty it shall be to report at the next annual meeting subjects for investigation and discussion, and if the subjects are approved by the Association the President, as hereinafter provided, shall appoint committees to report on them. It shall also be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall determine whether such questions are suita-

ble ones for discussion, and if so, they shall so report them to the Association.

COMMITTEES ON INVESTIGATION.

Sec. 4. When the committee on subjects has reported and the Association approved of subjects for investigation, the President shall appoint special committees to investigate and report on them, and may authorize and appoint a *special* committee to investigate and report on any subject which a majority of the members present may approve of.

ARTICLE IX.

AMENDMENTS.

Sec. 1. This constitution may be amended at any regular meeting by a two-third vote of the members present, provided that written notice of the proposed amendments has been given at a previous meeting at least six months before.

BY-LAWS.

TIME OF MEETING.

I. The regular meeting of the Association shall be held annually on the Third Tuesday in June.

HOURS OF SESSION.

II. The regular hours of session shall be from nine o'clock a. m. to two o'clock p. m.

PLACE OF MEETING.

III. "Places for holding the Annual Convention may be proposed at any regular meeting of the Association. Before the final adjournment the places proposed shall be submitted to a vote of the members and within six months thereafter the Executive Committee shall select a place from the three which have received the highest number of votes."

QUORUM.

IV. At any regular meeting of the Association fifteen or more members entitled to vote shall constitute a quorum.

ORDER OF BUSINESS.

V. The business of the meetings of this Association shall, unless otherwise ordered by a vote, proceed in the following order;

1st. Opening Prayer.
2d. Calling the roll.
3d. Acting on the minutes of the last meeting.
4th. Address by the President.
5th. Admission of new members.
6th. Reports of Secretary and Treasurer.
7th. Assessment and announcement of annual dues.
8th. Appointment of Nominating Committee.
9th. Election of Auditing Committee.
10th. Unfinished business.
11th. New business.
12th. Reports of committees.
13th. Reading of papers and discussion of questions propounded by members.
14th. Routine and miscellaneous business.
15th. Election of officers.
16th. Adjournment.

QUESTIONS FOR DISCUSSION, SPECIAL ORDER OF.

VI. Unless otherwise ordered, the discussion of questions proposed by members shall be the special order from 12 o'clock m. to one p. m., of each day of the annual meeting.

DECISIONS.

VII. The votes of a majority of the members shall be required to decide any question, motion or resolution which shall come before the Association unless otherwise provided.

DISCUSSIONS.

VIII. No patentees or their agents shall be admitted in the meetings of the Association for the purpose of advocating the claims of any patent or patentee, unless by unanimous consent.

IX. No member shall speak more than twice in the discussion of any question until all the other members who want to speak and have not been heard have spoken.

COMMITTEES FOR CONDUCTING THE BUSINESS OF THE YEAR 1889–90.

No. 1. Exhaust Pipes, Nozzles and Steam Passages; best form and size in proportion to Cylinders.

C. F. Thomas,
A. W. Gibbs,
Ross Kells,
John A. Hill.

No. 2. Compound locomotives; their efficiency as compared with simple engines.

J. Davis Barnett,
John Player,
H. D. Garrett,
F. W. Dean.

No. 3. Testing Laboratories, Chemical and Mechanical.

Philip Wallis,
George Gibbs,
G. W. West,
D. L. Barnes.

No. 4. Efficiency of the Link, as compared with other valve motions.

James M. Boon,
David Clark,
H. Tandy,
John A. Coleman.

No. 5. Advantages and disadvantages of placing the Fire-Box above the frames.

FRED B. GRIFFITH,
JAMES MACBETH,
W. A. FOSTER,
L. F. LYNE.

No. 6. Relative value of Steel and Iron Axles.

JOHN MACKENZIE,
J. S. GRAHAM,
JOHN S. COOK,
THOMAS SHAW.

No. 7. Brick Arches in Locomotive Fire-Boxes.

T. W. GENTRY,
ALLEN COOKE,
L. C. NOBLE,
W. A. SMITH.

No. 8. The best means, and the economy of preserving Locomotive Tanks from Corrosion.

W. J. ROBERTSON,
ALBERT GRIGGS,
O. STEWART,
JEROME WHEELOCK.

No. 9. Purification or softening of Feed Water.

W. T. SMALL,
HARVEY MIDDLETON,
A. W. QUACKENBUSH,
JOHN W. HILL.

No. 10. The best form and size of Axles for heavy tenaers

W. SWANSTON,
W. GARSTANG,
JAMES MAGLENN,
L. R. POMROY.

No. 11. The present status of the "Automatic Car Coupler Question," and whether this Association can endorse the action of the M. C. B. Association in recommending the vertical plane type as a standard, from a mechanical standpoint.

JOHN HICKEY,
G. W. RHODES,
SANFORD KEELER,
M. N. FORNEY.

Obituary—George G. Watrous.

C. E. SMART,
T. J. HATSWELL,
S. D. BRADLEY.

Obituary—S. W. Haines.

L. H. TURNER,
WM. FLAHAVEN,
E. RICHARDSON.

Executive Committee and Trustees of Boston Fund and Printing Fund.

R. H. BRIGGS,
JOHN MACKENZIE,
ALBERT GRIGGS,
O. STEWART,
ANGUS SINCLAIR.

Custodian of Boston Fund.

J. H. SETCHEL.

Committees on Subjects for Investigation and Discussion.

JOHN HICKEY,
H. TANDY,
W GARSTANG.

NAMES AND ADDRESSES OF MEMBERS.

NAME.	ROAD.	ADDRESS.
Ackley, J. D.		Kankakee, Ill.
Addis, J. W.	Texas & Pacific	Gouldsboro, La.
Aldcorn, Thos.	West Shore	New Durham, N. J.
Ames, L.	Beech Creek	Jersey Shore, Pa.
Anderson, J. H.		Providence, R. I.
Anderson, E. D.		Vicksburgh, Miss.
Arp, W. C.	C. St. L. & P.	Logansport, Ind.
Austin, W. L.	Baldwin Locomotive	Wks., Philadelphia, Pa.
Augustus, W.	Keokuk & Western	Centerville, Ia.
Ball, A. W.	N. Y. L. E. & W.	Galion, O.
Ball, Chas. A.	Georgetown & Western	Georgetown, S. C.
Barnes, J. B.	Wabash	Springfield, Ill.
Barnett, J. Davis	Grand Trunk	Stratford, Ont.
Barnett, T. E.	Canadian Pacific	Vancouver, B. C.
Barr, J. N.	C. M. & St. P.	Milwaukee, Wis.
Barton, J. C.		Hartford, Conn.
Battye, John E.	Shenandoah Valley	Milnes, Va.
Bean, John	C. & Canton	Canton, Ohio.
Beckert, Andrew	Louisville & Nashville	Decatur, Ala.
Billings, W. R.	Taunton Locomotive	Wks., Taunton, Mass.
Bisset, John	W. W. C. & A.	Wilmington, N. C.
Black, John		Lima, Ohio.
Blackall, R. C.	D. & H. Canal Co.	Albany, N. Y.
Blackwell, Chas.	Toledo, St. Louis & K. City	Frankfort, Ind.
Boatman, F. P.	Ohio & Miss.	Vincennes, Ind.
Boon, J. M.	West Shore	Frankfort, N. Y.
Bradley, S. D.	G. R. & Ind.	Grand Rapids, Mich.
Bradley, W. F.	K. & O.	Charleston, W. Va.
Bradt, Joseph		Rochester, N. Y.
Brastow, L. C.	C. & N. Jersey	Ashley, Pa.
Briggs, R. H.	K. C. M. & B.	Memphis, Tenn.
Brook, Geo. B.	B. C. R. & N.	Cedar Rapids, Ia.
Brown F. R. F.		Montreal, Quebec.
Brownell, F. G.		Burlington, Vt.
Bryan, H. S.		St. Paul, Minn.

NAME.	ROAD.	ADDRESS.
Burford, H. N.	Texas & Pacific	Marshall, Tex.
Buchanan, Wm.	N. Y. C. & H. R.	New York, N. Y.
Bushnell, R. W.	B. C. R. & N.	Cedar Rapids, Ia.
Campbell, John	Lehigh Valley	Delano, Pa.
Carmody, T.	N. Y. P. & O.	Cleveland, O.
Carson, M. T.	Mobile & Ohio	Jackson, Tenn.
Casanave, F. D.	P. Ft. W. & C.	Ft. Wayne, Ind.
Chapman, N. E.		Philadelphia, Pa.
Chapman, T. L.	Central Georgia	Savannah, Ga.
Clark, David	Lehigh Valley	Hazelton, Pa.
Clark, Peter	Grand Trunk	Toronto, Ont.
Clark, Isaac W.	C. F. & Y. V.	Fayetteville, N. C.
Clifford, J. G.	L. & Nashville	Mobile, Ala.
Cloud, Jno. W.		Buffalo, N. Y.
Collier, M. L.	Western & Atlantic	Atlanta, Ga.
Cooper, H. L.	4412 Wabash Ave., Chicago, Ill.	
Cooke, Allen	C. & E. Ill.	Danville, Ill.
Cook, John S.	Georgia	Augusta, Ga.
Cory, C. H.	C. H. & D.	Lima, Ohio.
Cromwell, A. J.	Baltimore & Ohio	Baltimore, Md.
Cullen, Jas.	N. C. & St. L.	Nashville, Tenn.
Curran, Peter	N. Y. L. E. & W.	Bradford, Pa.
Cushing, G. W.	Union Pacific	Omaha, Neb.
Dallas, Wilbur C.	947 Desoto St., St. Paul, Minn.	
Davis, Jas. A.	N. T. & Q.	Deseronto, Ont.
Davis, N. L.	Rutland	Rutland, Vt.
Dewson, E. H.	St. J. & G. Island	St. Joseph, Mo.
Divine, J. F.	W. &. Weldon	Wilmington, N. C.
Dickson, G. L.	Dickson Locomotive Wks., Scranton, Pa.	
Dickson, J. P.	Dickson Locomotive Wks., Scranton, Pa.	
Dolbeer, Alonza	B. R. & Pittsburgh	Rochester, N. Y.
Domville, C. K.	Grand Trunk	Hamilton, Ont.
Downe, Geo.	Government	Sidney, N. S. Wales.
Dripps, W. A.	3224 Walnut St., Philadelphia, Pa.	
Durrell, D. J.	Snow Shovel Co., Paterson, N. J.	
Eastman, A. J.		Sutton, Quebec.
Eddy, W. H.	Boston & Albany	Springfield, Mass.
Elliott, Henry		East St. Louis, Ill.
Ellis, Matt	C. St. P. M. & O.	St. Paul, Minn.
Ennis, W. C.	N. Y. S. & W.	Wortendyke, N. J.
Ettinger, G. W.	120 Broadway, New York.	

NAME.	ROAD.	ADDRESS.
Evans, Edward	C. W. & B.	Chillicothe, Ohio.
Evarts, D. T.		Boston, Mass.
Fenwick, A.	G. B. W. & St. P.	Green Bay, Wis.
Ferguson, G. A.		Lake Village, N. H.
Ferguson, Z. J.	Mobile & Ohio	Jackson, Tenn.
Ferry, F. J.	Louisville, St. Louis & Tex.	Henderson, Ky.
Finlay, L.	902 West 4th St., Little Rock, Ark.	
Flahaven, W. M.	Pittsburgh & Western	Allegheny, Pa.
Forsyth, Wm.	C. B. & Q.	Aurora, Ill.
Foss, J. M.	Central Vt.	St. Albans, Vt.
Foster, W. A.	Fall Brook Coal Co.	Corning, N. Y.
Fowle, I. W.	Colorado Midland	Leadville, Col.
Fraser, T. A.	M. S. S. M. & A.	Minneapolis, Minn.
Fuller, William	213 Kennard St., Cleveland, Ohio.	
Galloway, A.	T. A. A. & N. M.	Owosso, Mich.
Garrett, H. D.	Pennsylvania	Philadelphia, Pa.
Garstang, Wm.	Ches. & Ohio	Richmond, Va.
Gates, W. G.		Salisbury, N. C.
Gentry, T. W.	Richmond & Danville	Richmond, Va.
George, Nathan M.		Danbury, Conn.
Gibbs, A. W.	Richmond & Danville	Alexandria, Va.
Gibbs, George	C. M. & St. P.	Milwaukee, Wis.
Gilmour, W. L.	L. S. & M. S.	Elkhart, Ind.
Givan, F. A.	Ches. & Ohio	Huntington, W. Va.
Gordon, H. D.	P. W. & Baltimore	Wilmington, Del.
Gordon, Jas. T.	Concord	Concord, N. H.
Graham, Chas.	D. L. & Western	Scranton, Pa.
Graham, J. S.	L. S. & M. S.	Cleveland, Ohio.
Greatsinger, J. L.	D. & I. Range	Two Harbors, Minn.
Greenwood, A. W.	East Broad Top	Orbisonia, Pa.
Griffith, Fred B.	D. L. & Western	Buffalo, N. Y.
Griggs, Albt.	P. & Worcester	Providence, R. I.
Gugel, Danl. M.	Centl. Ga.	Macon, Ga.
Hackney, Clem	624 Washington St., Milwaukee, Wis.	
Hackney, George	C. S. F. & Cal.	Chicago, Ill.
Hackney, Herbert		Topeka, Kan.
Haggett, J. C.	D. & A. Valley	Dunkirk, N. Y.
Haggarty, G. A.	New Brunswick	St. Johns, N. B.
Hall, Don Diego	Government Railways	Santiago, Chili
Hall, J. N.		Montgomery, Ala.
Ham, C. T.	Buffalo Steam Gauge Co., Rochester, N. Y.	
Hanson, C. F.	Grand Trunk	London, Ont.

NAME.	ROAD.	ADDRESS.
Harding, B. R.	R. G. R. & A.	Raleigh, N. C.
Harrington, S. H.	N. Y. L. E. & W.	Susquehanna, Pa.
Harris, Geo. D.	Richmond & Danville	Salisbury, N. C.
Harrison, W. H.		Newark, Ohio.
Hatswell, T. J.	F. & P. M.	East Saginaw, Mich.
Hazelton, G. H.	R. W. & O.	Oswego, N. Y.
Hassman, Wm.	R. & Alleghany	Richmond, Va.
Haynes, O. A.		St. Louis, Mo.
Hemphill, W. J.	Jacksonville South E.	Jacksonville, Ill.
Hendee, A.	Westinghouse Air Brake Co., Pittsburgh, Pa.	
Henney, J. B.	N. Y. & N. E.	Boston, Mass.
Heintzelman, T. W.	So. Pac.	Sacramento, Cal.
Hewitt, John	Wabash Western	Butler, Ind.
Hickey, John	M. W. S. & Western	Kaukauna, Wis.
Higgins, S.	N. Y. P. & O.	Meadville, Pa.
Hill, Jas. W.	Peoria & Pekin Union	Peoria, Ill.
Hinman, M. L.	Brooks Loco. Wks., Dunkirk, N. Y.	
Hobart, C. C.		The Dalles, Ore.
Hodgman, S. A.	Lobdell Car Wheel Co., Wilmington, Del.	
Hoffecker, W. L.	Central of New Jersey	Elizabethport, N. J.
Holman, W. L.	Penna.	Renova, Pa.
Horniblow, J. P.	Government	Brisbane, Q. land
Hughes, E. W. M.	Rookery Building, Chicago, Ill.	
Haller, W. J.	Ches. & Ohio	Richmond, Va.
Irby, Chas.	K. C. F. S. & M.	West Memphis, Ark.
Jackson, O. H.	O. & Miss.	Vincennes, Ind.
Jacques, Richard	Hemenway & Brown	Boston, Mass.
Jeffery, E. T.	Ill. Cent.	Chicago, Ill.
Johann, Jacob		Springfield, Ill.
Johns, C. T.	Valley	Cleveland, Ohio.
Johnson, J. B.	A. Midland	Helena, Ark.
Johnson, L. R.	Canadian Pacific	Vancouver, B. C.
Johnstone, F. W.	Mexican Central	City of Mexico.
Joughins, G. R.	Erie & Huron	Chatham, Ont.
Kamington John	So. Pac.	Lathrope, Cal.
Keeler, Sanford	F. & P. M.	East Saginaw, Mich.
Kiehner, John I.	2341 E. York St., Philadelphia, Pa.	
Kiley, M. R.	St. Jo. & G. I.	St. Joseph, Mo.
Kells, Leroy	P. C. & St. L.	Cincinnati, Ohio.
Kells, Ross	N. Y. L. E. & W.	New York
Kimball, N. S.	M. & Northern	Green Bay, Wis.
Kinsey, J. I.	Lehigh Valley	Easton, Pa.

NAME.	ROAD.	ADDRESS.
Lannon, Wm.	House of Representatives,	Washington, D. C.
Lape, C. F.	Wabash	Springfield, Ill.
Lape, J. K.	St. J. St. L. & S. F.	St. Joseph, Mo.
Lauder, J. N.	Old Colony	Boston, Mass.
Lavery, W.	N. Y. L. E. & W.	Susquehanna, Pa.
Leach, H. L.		1 Rollins St., Boston, Mass.
Leeds, Pulaski	L. & Nashville	Louisville, Ky.
Leigh, F. J.	Canadian Loco. Wks.,	Kingston, Ont.
Lewis, W. H.	D. L. & Western	Kingsland, N. J.
Lewis, William H.	C. B. & Northern	La Crosse, Wis.
Losey, Jacob	Steam Forge Co.,	Louisville, Ky.
Luttgens, H. A.	Rogers Loco. Works,	Paterson, N. J.
Lythgoe, Joseph	R. I. Loco. Wks.,	Providence, R. I.
Mackenzie, John	N. Y. C. & St. L.	Cleveland, Ohio
Manly, Basil	A. & N. C.	Newberne, N. C.
Maver, A. A.	Grand Trunk	Stratford, Ont.
Macbeth, James	West Shore	Buffalo, N. Y.
McCrum, J. S.	K. C. Ft. S. & G.	Kansas City, Mo.
McFarland, Wm.		725 Edgerton St., St. Paul, Minn.
Maglenn, James	Carolina Central	Laurenburg, N. C.
McGrayel, John	C. R. I. & P.	Grand Junction, Ia.
McNiven, P. C.	Canadian Loco. Wks.	Kingston, Ont.
McKenna, John	I. D. S.	Indianapolis, Ind.
Medway, John	Fitchburg	Mechanicsville, N. Y.
Meehan, James	C. N. O. & T. P.	Ludlow, Ky.
Michael, J. B.	E. T. V. & Ga.	Knoxville, Tenn.
Middleton, Harvey	A. T, & S. Fe.	Topeka, Kan.
Midelton, Thomas	Government Railways	Sydney, N. S. W.
Millen, Thomas	New York City & N.	High Bridge, N. Y.
Miller, E. A.	N. Y. C. & St. L.	Conneaut, O.
Minshull, E.	N. Y. O. & W.	Middletown, N. Y.
Mitchell, A.	Lehigh Valley	Wilkes-Barre, Pa.
Montgomery, Wm.	C. of N. J.	Manchester, N. J.
Moore, J. H.	N. Y, L. E, & W.	Port Jervis, N. J.
Morrell, J. E.	C. R. I. & P.	Davenport, Ia.
Morris, W. S.	Wabash	Ft. Wayne, Ind.
Morse, G. F.	Portland Loco. Works,	Portland, Me.
Mulligan, J.	Conn. River	Springfield, Mass.
Murphy, J. H.	N. Y. L. E. & W.	Buffalo, N. Y.
Nichols, Edward	Brooks Loco. Wks.,	Dunkirk, N. Y.
Noble, L. C.	H. & T. C.	Houston, Texas.

NAME.	ROAD.	ADDRESS.
Olcott, H. P.		Coolidge, Kas.
Ortton, John		Albany, N. Y.
Patterson, J. S.	L. S. & M. S.	Cleveland, O.
Paxson, L. B.	P. & R.	Reading, Pa.
Peck, Peter H.	C. & W. I. & Belt	Chicago, Ill.
Perry, F. A.	Cheshire	Keene, N. H.
Petrie, Ira	702 East State st., Jacksonville, Ill.	
Phelan, J. E.	Northern Pacific	Mandan, Dak.
Pitkin, A. J.	Schenectady Loco. Works, Schenectady, N. Y.	
Place, T. W.	Illinois Central	Waterloo, Iowa.
Player, John	Wisconsin Central	Waukesha, Wis.
Porter, Joseph	C. S. & C.	Sandusky, Ohio.
Prescott, G. W.	California Central	San Bernardino, Cal.
Prescott, G. H.	T. H. I. & St. L	Terre Haute, Ind.
Pilsbury, Amos	Maine Central	Waterville, Me.
Pringle, R. M.	1101 N. Second St., St. Louis, Mo.	
Purvis, T. B.	Boston & Albany	East Albany, N. Y.
Quackenbush, A. W.	Chicago & Alton	Bloomington, Ill.
Quayle, Robert	Chicago & Northwestern	Clinton, Ia.
Quinn, John A.	C. V. & C.	Mt. Carmel, Ill.
Ramsay, J. C.	Illinois Central	Memphis, Tenn.
Randolph L. S.	Cum. & Penna.	Mt. Savage, Md.
Ransom, T. W.	N. Y. L. E. & W.	Hornellsville, N. Y.
Reed, W. T.	C. St. P. & K. C.	St. Paul, Minn.
Rennel, Thomas	M. & L. R.	Argenta, Ark.
Renshaw, W.	Illinois Central	Chicago, Ill.
Reynolds, W. W.	C. St. L. & P.	Columbus. O.
Rhodes, G. W.	C. B. & Q.	Aurora, Ill.
Richardson, E.	S. & A.	Shenango, Pa.
Richardson, R. M.	Missouri Pacific	Little Rock, Ark.
Rickard, C. W.	Zapiga Ferro Caril	Pisagua, Chili.
Robb, W. D.	L. & Nashville	Pensacola, Fla.
Roberts, E. M.	A. C. & I. Co.	Ashland, Ky.
Robertson, W. J.	C. Vermont	St. Albans, Vt.
Robinson, John	L. S. & M. S.	Buffalo, N. Y.
Ross, Geo. B.	293 S. Division st., Buffalo, N. Y.	
Rossiter, C. W.	Northern Pacific	Duluth, Minn.
Sample, N. W.	D. & R. G.	Denver, Colo.
Sanborn, C. A.		Address Lost.
Sanborn, J. M.	L. S. & M. S.	Norwalk, O.
Schaeffer, Aug.	Maysville Water Works, Maysville, Ky.	

NAME.	ROAD.	ADDRESS.
Schlacks, Henry	Ill. Central	Chicago, Ill.
Sedgwick, E. B.		Marquette, Mich.
Selby, W. H.		Huntington, Ind.
Sellers, Morris		6 Ashland Block, Chicago, Ill.
Setchel, J. H.		Cuba, N. Y.
Shaver, D. O.	Penna.	Pittsburg, Pa.
Sheppard, F. L.	Penna.	Altoona, Pa.
Short, W. A.	O. & L. C.	Malone, N. Y.
Skinner, H. M. C.		N. Y. Loco. Works, Rome, N. Y.
Small, H. J.	Southern Pacific	San Francisco, Cal.
Small, W. T.	Northern Pacific	St. Paul, Minn.
Smart, C. E.	Michigan Central	Jackson, Mich.
Smith, Allison D.	Government	New Port, Victoria.
Smith, F. C.		Delaware, Ohio.
Smith, Howard M.	Richmond & Danville	Alexandria, Va.
Smith, Wm.	Boston & Maine	Boston, Mass.
Smith, W. T.	Newport News & Miss.V.,	Lexington, Ky.
Sprague, H. N.		Porter Loco. Works, Pittsburgh, Pa.
Stapf, F. M.		Mt. Carmel, Ill.
Stearns, W. H.	Conn. River	Springfield, Mass.
Stephens, S. A.		Rhode Island Loco. Works, Providence, R. I.
Stevens, Geo. W.	L. S. & M. S.	Cleveland, O.
Stewart, O.	Fitchburg	Charlestown, Mass.
Stinard, F. A.		Pompton Junc., N. J.
Stokes, J. W.	Ohio & Miss.	Pana, Ill.
Stone, W. A.	L. E. & St. L.	Huntingburg, Ind.
Strode, James	N. Central	Elmira, N. Y.
Sullivan, A. W.	Illinois Central	Chicago, Ill.
Swanston, Wm.	C. St. L. & P.	Indianapolis, Ind.
Tandy, H.	N. Y. O. & W.	Middletown, N. Y.
Taylor, J. K.		Address Lost.
Teal, S. A.	F. E. & M. V.	Missouri Valley, Iowa.
Thatcher, Thos.	D. L. & W.	Utica, N. Y.
Thomas, C. F.	E. T. V. & Ga.	Atlanta, Ga.
Thomas, W. H.	E. T. V. & Ga.	Knoxville, Tenn.
Thomas, W. J.	North P. Coast	Sausalite, Cal.
Thompson, W. A.	M. H. & O.	Marquette, Mich.
Thow, Wm.	Government	Sydney, N. S. Wales.
Tinker, S. B.	C. W. & Mich.	Wabash, Ind.
Torrence, John	E. & T. H.	Evansville, Ind.
Tregelles, Henry		Westinghouse Air Brake Co., Pittsburg, Pa.
Tuggle, S. R.	Kentucky Central	Covington, Ky.
Turner, Chas. C.	W. N. Y. & Pa.	Olean, N. Y.

NAME.	ROAD.	ADDRESS.
Turner, J. S.	Eames Vacuum Brake Co., New York.	
Turner, L. H.	Pitt. & L. Erie	Chartiers, Pa.
Turreff, W. F.	C. C. C. & I.	Cleveland, O.
Twombly, A. W.	Old Colony	Taunton, Mass.
Twombly, Fred N.	Old Colony	Boston, Mass.
Twombly, T. B.	C. R. I. & P.	Chicago, Ill.
Tynan, F. F.	Bay of Havana	Matanzas, Cuba.
Ulmo, H. A.	C. & Savannah	Savannah, Ga.
Underhill, A. B.	B. & Albany	Springfield, Mass.
Vail, A.	W. N. Y. & Pa.	Buffalo, N. Y.
Van Vechtan, J.		Port Jervis, N. J.
Voss, William	Rookery Bldg., Chicago, Ill.	
Wakefield, S. W.	C. R. I. & P.	Keokuk, Ia.
Walker, C. W.	S. & Roanoke	Portsmouth, Va.
Wall, E. B.	P. C. & St. L.	Columbus, O.
Wallis, Herbert	Grand Trunk	Montreal, Canada.
Wallis, Philip	C. B. & Q.	Beardstown, Ill.
Walsh, Thomas	L. & Nashville	Mt. Vernon, Ill.
Wanklyn, F. L.	Grand Trunk	Montreal, Canada.
Ward, C. F.	St. P. & D.	St. Paul, Minn.
Warren, Beriah	T. P. & W.	Peoria, Ill.
Warren, W. B.	2808 Lafayette av., St. Louis, Mo.	
Watts, Amos H.	Station "C," Cincinnati, Ohio.	
Webb, F. W.	L. & N. W.	Crewe, England.
Webber, H. N.	N. Y. Loco. Works, Rome, N. Y.	
Weisgerber, E. L.	B. & O.	Newark, O.
Wells, Reuben	Rogers Loco. Works, Paterson, N. J.	
West, G. W.	N. Y. L. E. & W.	Jersey City, N. J.
Wheeler, M. C.	Central Iowa	Marshalltown, Iowa.
White, A. M.	Schenectady Loco. Works, Schenectady, N. Y.	
Whitlock, Joseph	N. H. & D.	Ansonia, Conn.
Whitney, H. A.	Intercolonial	Moncton, N. B.
Wightman, D. A.	Pittsburgh Loco. Works, Allegheny, Pa.	
Willard, Daniel	757, 18½ av., N. E., Minneapolis, Minn.	
Williams, C. G.	C. of N. J.	Communipaw, N. J.
Williams, R.	N. Y. Loco. Works, Rome, N. Y.	
Winslow, J. M.	Calle de Ortega No. 28, City of Mexico.	
Wilson, G. F.	C. R. I. & P.	Horton, Kans.
Wilson, John	Union Pacific	Omaha, Neb.
Wilson, William	C. A. & St. L.	Bloomington, Ill.
Worcester, F. E.	D. S. S. & A.	Marquette, Mich.

ASSOCIATE MEMBERS.

Barnes, D, L.	Chicago, Ill.
Coleman, John A.	Providence, R. I.
Dean, F. W.	2 Central Square, Cambridgeport, Mass.
Forney, M. N.	145 Broadway, New York.
Gordon, Alex.	Niles Tool Works, Hamilton, Ohio.
Hill, John A.	96 Fulton st., New York, N. Y.
Hill, John W.	Cincinnati, Ohio.
Lyne, L. F.	307 Grove st., Jersey City, N. J.
Miles, F. B.	Bement & Miles, Philadelphia, Pa.
Pomeroy, L. R.	Suburban Rapid Transit New York.
Shaw, Thomas	915 Ridge st., Philadelphia, Pa.
Sinclair, Angus	Morse Building, New York.
Smith, John Y.	Doylestown, Pa.
Smith, W. A.	Rookery Building, Chicago, Ill.
Wheelock, Jerome	25 Elizabeth st., Worcester, Mass.

HONORARY MEMBERS.

Coolidge, G. A.	Charlestown, Mass.
Cummings, S. A.	Dorchester, Mass.
Dripps, Isaac	345 Walnut st., Philadelphia, Pa.
Eddy, Wilson	Springfield, Mass.
Peddle, C. R.	Terre Haute, Ind.
Perrin, P. J.	Taunton, Mass.
Philbrick, J. W.	Waterville, Me.
Richards, Geo.	14 Auburn st., Roxbury, Mass,
Robinson, W. A.	Hamilton, Ont.
Sedgely, James	Cleveland, O.
Thompson, John	137 Webster st., East Boston, Mass.
Towne, H. A.	256 First av., Minneapolis, Minn.
White, J. L.	Danville, Ill.
Williams, E. H.	Baldwin Loco. Works, Philadelphia, Pa.

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REPORT OF THE PROCEEDINGS

OF THE

TWENTY-THIRD ANNUAL CONVENTION

OF THE

American Railway Master Mechanics' Association,

HELD AT

OLD POINT COMFORT, VA.,

JUNE 17th, 18th and 19th, 1890.

EDITED BY ANGUS SINCLAIR, SECRETARY.

NEWARK, N. J.:
ADVERTISER PRINTING HOUSE,
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NEWARK, N. J.:
ADVERTISER PRINTING HOUSE,
1890.

AMERICAN RAILWAY

MASTER MECHANICS' ASSOCIATION.

Officers for 1890-91.

PRESIDENT.

JOHN MACKENZIE,

Cleveland, Ohio.

FIRST VICE-PRESIDENT,

JOHN HICKEY,

Kaukauna, Wis.

SECOND VICE-PRESIDENT,

WILLIAM GARSTANG,

Richmond, Va.

TREASURER,

O. STEWART,

Charlestown, Mass.

SECRETARY,

ANGUS SINCLAIR,

New York.

PROCEEDINGS.

PRELIMINARY.

The Twenty-Third Annual Convention of the American Railway Master Mechanics' Association was held in the Hygeia Hotel, Fortress Monroe, Va., on June 17, 18 and 19, 1890. President R. H. Briggs in the Chair.

President Briggs called the meeting to order on June 17, at 9.30 A. M.

At the request of President Briggs the Rev. George Royal invoked the divine blessing upon the meeting.

ADDRESS OF WELCOME.

Mr. M. E. Ingalls, President of the Chesapeake & Ohio Railway was introduced to the meeting by President Briggs. Mr. Ingalls said:

"It is hardly worth your time for me to discuss the particular matters which you will consider at your meetings. I know but little about engines, wheels, axles or cars, while you are full of information. I am delighted to see so many here and representing such large interests in this country as you do. Probably your associations, with their ramifications, including supply men and employes, represent more of a population than the whole United States contained in 1830, when the first railroad was inaugurated. It cannot but be of benefit to you and to the railroads, that you meet together and discuss matters of interest. Another reason in favor of such meetings, and equally good, is the fact that it gives you a few days rest from hard work, enables you to see something outside of the shop and to get a few bright moments in life where pleasure and not work is the rule of the

hour. We are indebted to you for having selected this place, and certainly no fairer one could have been found for your meeting. As far as the Chesapeake & Ohio Railway is concerned, I am authorized to say that its doors swing wide open in hospitality to you and whatever you want, from the salt sea waves at this end to the waters of the Ohio at Cincinnati, you can have. We hope that either in coming or going, or while here, you will take a ride over it and and look at it. We are proud of it. A few years ago its name was a byword and reproach among railroads. Today it can compete with any, in track, equipment and business, and in the *esprit de corps* of its men it will not yield to any. All this has been accomplished in a short time, and we would be glad to have you view it critically. Not long since, its stock and bonds were selling for almost nothing and financial people hesitated to admit that they were the owners of the same, but today its securities are current in the financial markets of the world as among the best, and we hope to make them still better. We can only do so by having such men as yourselves visit us, ride over the property and see it.

And now, if you will permit, I would like to leave the dull air of machine shops and railways and take you into a little of the history and romance that surrounds you in this country. Here on this bay which looks so peaceful and quiet, the life of a nation was fought for, twenty-eight years ago last March, in one of the most desperate naval battles ever known. Some of you may go back in mind to that gloomy day of the 8th of March when the Merrimac sailed out from Norfolk, and the fleet of the North, lying at anchor under the protecting walls of Fortress Monroe, went down like wheat before the reaper. Alarm reigned everywhere; it was supposed that the blockade would be broken and that the cities of the North would be at her mercy. That night, Worden with his strange little craft, the Monitor, sailed up the bay and the next morning the most novel and most hotly contested fight of the war was witnessed in this harbor, and the Merrimac was driven back to her moorings and the cities of the coast were saved. Looking at it this morning, you can hardly conceive that within about a quarter of a century men should have struggled like demons for mastery upon its waters. Within

a hundred miles of this place there are more historic associations than in any place on this continent; there are more shrines where the pilgrims of this country should visit and worship than any that I know of in this or the old world. If you will go up the James River fifty miles, to Jamestown, you will find where two hundred and eighty-three years ago the first settlement was made in this country; there is the old church crumbling to ruins; there are the gravestones which were erected with the fond hope of making the names of those buried there eternal; and yet the storms of two hundred and fifty years have effaced the very letters, the trees have grown up through the graves and carried the gravestones up with them; and, as a travesty on the efforts of man to leave some permanent record of himself, you will find the gravestones in the trees up in the air, and nothing left but shrubbery and desolation to mark the first settlement in this country.

If this is too ancient for you, cross the peninsula to the York River and see there the monument that has been erected marking the defeat and surrender of Cornwallis and the end of the first American revolution, and the place where the rebels of that day became rebels no longer but victors and leaders. Passing up on the Chesapeake & Ohio road some thirty miles you will come to Williamsburgh, the old capital of Virginia, the seat of William and Mary College, the oldest in this country except Harvard. You will find the town as gray and venerable and quiet as it was in the days when Lord Dunmore thundered his anathemas against the rebels who dared to defy the court of George the Third. Here in 1862, twenty-eight years ago, was the first serious fight in McClellan's celebrated advance on Richmond by the way of the peninsula. Farther up and before you reach Richmond, you will find the place where McClellan at the end of his seven days' fighting around Richmond, with his gallant army worn out, beaten but still brave and defiant, sternly fought their way towards the James River, and at Malvern Hill turned and gave the rebel forces such a beating as saved his army. Again, you will find the place where Grant crossed, after his terrific fight in the wilderness, in the last advance on Richmond in 1864. All around Richmond is historic ground; it was

the capital of the confederacy for four years and was the Southern headquarters of a war such as no other modern countries have witnessed. Up along our James River Division is the weary road where Lee, after Richmond was no longer defensible, tried to retreat and join the other forces of the Confederacy. But a few miles from the line is the celebrated apple tree at Appomattox, where the surrender of Lee to Grant took place. This settlement has never had its merits properly set forth. Fortunate was it for this country that both the North and South had not only great generals but great and magnanimous men in command; otherwise, we might have had a different conclusion and results that would have been disastrous to our country. This settlement was made and it led ultimately to the surrender of all the rebel army and prevented a long guerrilla warfare, which there was danger of if a different plan had been pursued.

Riding along in the cars today, looking at the country, peaceful and quiet, you can hardly conceive that twenty-five years ago it was the battlefield of nations. I would be very glad to have you visit Richmond and the other cities in Virginia, along our line, so that you can see for yourselves how these people have repaired the wastes of war in the twenty-five years that have passed since peace was proclaimed. At that time there probably never was a country more desolate than Virginia. In some places, as was said by one of our distinguished generals, "even a crow could not fly over it without taking rations." Farm houses were destroyed, stock had been driven off, fields had gone to waste; there was no money, nothing left to begin with. In the cities, the banks were broken, credit was gone and there was no capital; everybody was poor. They had only their houses to start with, and in many locations not even that, for the business portions of many of the cities had been destroyed by fire, shot and shell; and yet today you will find the city of Richmond, with its one hundred thousand people, as prosperous as any northern city of its size; you will find its banking institutions as solid and stable; almost as if by magic have they built up their ruined homes and broken industries; and a stranger from another land who should come here today, knowing nothing of its history, would never

for an instant believe that this place had been the headquarters of battles for four years, and that twenty-five years ago it was desolation itself.

There have been some things that have impeded its rapid growth. In the first, there was prejudice against northern men, and there was a dislike on the part of nothern men to come south until they were sure the government was stable. We have had a great many people in the north, who believed that if the democratic party should come into power, the country would be ruined; but the republicans went out, Cleveland came in, ruled for his four years; and peace and prosperity continued as before. Again, the people of the south thought if the republican administration should return to power, it would be an ill day for them, and yet the change was made quietly and peaceably. The present administration has been in power for two years, and the wheat and corn grow the same on the hillsides of Virginia as they did before, and prosperity still continues. All this has given confidence to people and invited capital from other countries, and the result is today this whole State of Virginia is on what is called a "boom," and it seems a legitimate one. The land which has lain here uncultivated for a hundred years, gathering richness from its idleness, is ready today to respond to the demands of the farmer in good crops with good tillage; the mountains are full of iron; the coal is in immediate proximity, and in addition to all, the most charming climate in the States is to be found here. You will find in this State iron ore in abundance, next to it lime stone, and within a hundred miles the finest coking coal for the manufacture of iron yet known. With these elements in close proximity, it may be a question in the next few years whether Pittsburgh, Birmingham or Virginia shall be the centre of the iron and steel manufactories of this country. The result is that an army almost as large as that which in 1862 landed here, and pressed up the peninsula in its march on Richmond, is today advancing upon Virginia, their knapsacks filled with the savings of years instead of gunpowder and bullets; villages are springing up everywhere, furnaces are being built, rolling mills erected, and this grand old State bids fair in the next ten years to wake up from

its lethargy, and again come to the front as one of the busy and powerful States of the Union.

There are two things which have seriously retarded her prosperity,—the non-payment of her debt, and the difficulty over the colored vote. The people here in Virginia claim that they are interwoven and one depends on the other, that the debt was in a fair way of settlement, until the struggle for the control of the colored vote disturbed and prevented it. There is no doubt but that it has been a great injury to the development of the State, and her better citizens feel keenly the disgrace of the situation. It seems to me clearly a case for compromise. The State was divided by the National Government, and a large part of her domain erected into another commonwealth under the name of West Virginia; and yet she was relieved of no equivalent portion of the debt. This ought to be taken into consideration. States are not different from individuals, and the better way with the individual in financial trouble is for his creditors to adjust the matter speedily, put him on his feet and get him to earning money, so that in the future he can pay the debt. What ought to be done here in Virginia is for a commission to meet a committee of the bondholders, decide how much of the principal the State can pay, at what rate of interest it can be paid, and then fund the debt in long bonds with a sinking fund, so that it shall be distributed over so many years, that its payment will not be oppressive. In talking with her leading citizens, I find them all disposed to treat the matter fairly, and at the last session of the Legislature, a bill was passed creating a commission following out this idea, and on it are some of the ablest men in the State; and now if the bondholders will take it in hand and appoint their committees, the matter can all be speedily settled. It will take a great weight off the financial prosperity of the State, and wipe out a disgraceful episode in her career. The second difficulty (that of the colored vote) in my judgment, in the present situation, is not serious. When reconstruction was established in the southern states, the right of suffrage was given to all the former slaves. If two hundred years of slavery should fit a race for suffrage, it would be strange. The result was that the colored people when they came to politics were led

by demagogues and people who had their own selfish interests to serve, and where the colored vote predominated it was usually controlled against property. The result has been that the white people have been alarmed, and to solidify their vote it is only necessary to hold up the terror of the government passing into the possession of the colored people here. This is not a fight of "color," or because the negroes are black, or because they are negroes, but it is the fight that you see everywhere, north, west and south, of the property class against the irresponsible and ignorant classes controlling the government and taxation. I have given this subject much study and consideration in the months I have spent in this State. It has been a serious question in reference to the future of our property, and it has been a very interesting one to me as a student somewhat of political economy. I have seen no place in the world where the colored race was treated so kindly and so well as in Virginia, in regard to everything except voting. There is no doubt, but that in places where the colored vote is in the majority, by all ways and means in their power the white people have overcome that majority. They have carried the elections just as they are carried everywhere else, I am sorry to say, and either by fair or foul means prevented the negroes securing control. While it is wrong, and in the end will produce its punishment, who is there to throw the first stone? They have believed that the control of the government by the negroes meant the destruction and waste of their property, and I have never seen a community yet when it came to a direct question between property and misgovernment, that the property would not fight for its rights and in the end win. It is undoubtedly true that suffrage should only go with intelligence and education, and one way of solving this question here would be to amend the constitution of Virginia so that no man (white or black) could vote unless he could read and write; but any line that is a color line will never be supported or sustained by the people of this country; the nineteenth century will not justify *that* settlement of the difficulty. In discussing the matter of an "educational clause" in the constitution, with some of the leading people in this State, they have thought it would be

impossible to carry it, as it has to be submitted to a popular vote, and a vote of the very people (whites and blacks), who would be disfranchised by this test, and the number is large. I have seen in the last year a glimmer of light that is growing stronger, and which I believe in the next three years will solve this question anyway, if, in the meantime, the people can work along and exhibit patience, moderation and justice. The relief is coming from the "boomer." With the mines that are being opened in the State, with the mills that are being erected, with the villages that are being built up, with the emigration that is pouring in here from the north and west, the proportion of the colored vote will decrease, and it will become relatively so small shortly, that it will no longer be a menace to the prosperity and good government of the State. The moment that takes place, the temptation for the demagogue to use the colored vote will be done away with, and the negro will be left like other people to consider his own interests, and take the advice of his own friends, and his vote will divide and instead of having two parties here in this State, one white and the other colored, you will have two parties divided like they are in the states of the north, and the colored votes will be found on both sides. When that day comes, the future of Virginia is safe.

I hope you will pardon this semi-political speech; the place, the associations, the air is full of these thoughts; it is the burning question of the hour here, and, as representing one hundred millions of property interested in the question, I cannot but discuss it; and when I can get before me as large a body of intelligent men as I have today, from all parts of the country, I feel like planting my seed with full confidence in the harvest.

I thank you for your attention, and again offer you all that the Chesapeake & Ohio Railway has. Do not, I pray you, devote all your time to business, but take a fair share for pleasure, and in future years these few days shall be evergreens whose shade will solace the weary road of an active life like yours.

MR. J. DAVIS BARNETT—Mr. President: We have listened with such great pleasure to President Ingalls, that I am sure he need not have finished his address to us with an apology. That address had the real ring of a true

national spirit in it. It had an historic imagination and a poetic fancy, and language which surprised me, and which certainly interested and entertained us all. It is a pleasure to me to move a vote of thanks to the gentleman who, I feel assured, has sacrificed his time and convenience to meet us today. How far south President Ingalls reputation goes I know not, but northward, it goes very close to the North Pole; and to me it is one of the pleasures in coming down to Old Point Comfort, that I should have had the privilege of hearing President Ingalls address us. For the courtesies extended to us on behalf of the Railway he represents, we are thankful, and we beg to express our thanks through you, Mr. Chairman. The time is one of enjoyment to us. It has been well introduced. The recommendations made in this speech are those which we should pay attention to, and I feel sure that you will all heartily endorse the vote of thanks I herewith propose.

The motion was carried unanimously.

THE PRESIDENT'S ADDRESS.

President Briggs then delivered his inaugural address as follows:

Brethren of the American Railway Master Mechanics' Association, Ladies and Gentlemen. In the name of our honored society, I rise to give you a hearty greeting.

As we follow the example of our locomotives in the power to move from place to place, it is eminently right and proper that our convention should meet at "Old Point Comfort," where a new application of mechanics was successfully demonstrated by the genius of Ericsson in his famous Monitor, awakening and revolutionizing the navies of all nations. It is to Ericsson that we also owe the screw propeller, now in our day enabling the "greyhounds" of the ocean to plow the deep, transporting the people of all continents with such speed as to annihilate space and challenge the admiration of the world.

This man struggled to impress upon the minds of the scientific men and the capitalists of England, the advantages of the screw propeller, and was forced to abandon his efforts for want of encouragement; but in this country, where genius never applies in vain, the worth and value of his invention was recognized and appreciated, resulting in the steamship "Princeton," being equipped with that then called myth, now recognized as one of the greatest agencies of mankind in the locomotion of the steamship from shore to shore.

The prosperity of our country since our last assembly has been attested by a large additional railroad mileage, and we learn from reliable sources that more miles of new railroad will be built this year than in 1889. When we reflect that the extreme boundaries of our country are already connected by existing railroads, from the oceans that bathe our Eastern and Western shores to the Canadian and Mexican limits, we see at once that our railroads are not to reach new territory in any great bound, but are in the natural development of our internal country; and we, as master mechanics, have for our special work, not the creation of any new machine to accomplish locomotion, but rather the evolution of our present engine, that we may reach the highest efficiency in speed, in power, in durability and in safety, at the least cost in its original construction, combustion properties and expense of keeping up.

While the old wood-burning engines have generally given way to the modern coal burner, it is quite probable that in some sections of our country other fuel than coal may be successfully used, and we invite from all sections the suggestions of our associate mechanics to this important item in the cost of steam making.

The great diversity of territory through which our locomotives travel would seem to prevent anything like national uniformity in construction; severe grades demanding features in the engine not required over prairie country, and other special forms provided for use in special localities; but when we travel through our country and see the different locomotives at work, we cannot but be struck with the great similarity of these powerful machines, and we feel a glow of pleasure in the knowledge that the existing uniformity and excellence has been attained more through the labors of this association than from any other influence. This thought inspires us with confidence in our progression, and we look forward to our annual convention in the full security of individual improvement as members, and of an enlarged and enlightened service for the companies we represent.

As we contemplate the immense work that our locomotives have been made to perform in the transportation of the harvests

from the prairie to the seaboard, in the movement of all living and dead freight, creating cities, establishing markets, breathing life and civilization, making the "desert even blossom as a rose," let us not forget the grand army of faithful engineers and firemen to whose care these vast machines are entrusted; an army of men larger in numbers, stronger in discipline, richer in intelligence and higher in bravery than any of whom Alexander could ever boast. These men, largely recruited from humble life, form a perpetual monument to the mothers who gave them birth, true types of our American womanhood, who sent her boys to school and struggled so often with poverty and privation that her children should have every opportunity for gaining knowledge, and who by a lifetime of devotion has encouraged and fortified us all in the development of our progression.

Let us thank God for what has been gained, but let us not think that everything has be gained; much has been done, but much remains to be done. Science is daily improving our knowledge as to the combustion of fuel; mechanics are daily improving the learner in the care of these machines. It is not necessary now as in former days, when you and I were young men and members of the rank and file, to search after this knowledge—by the aid of a tallow candle perhaps; the knowledge thus obtained by those early pioneers of progress has been so concentrated and compiled that it is now within the reach of all; a few cents will place those most precious thoughts within the grasp of the student. Let us unite in our endeavor to educate our men in their profession; inducing them as far as practicable to read and think over the scientific literature flowing towards them. Animated with such knowledge coupled with their daily experience, the evolution of efficient service to our companies must result, and we and they will have an enduring place in the history of our progression.

Your committees have labored diligently with the work assigned to them at your last convention, and we bespeak for their reports your earnest attention, making special reference to the one on the compound locomotive.

We do not pretend to any knowledge in the untried future;

we would not at all be understood as desiring to frown upon any advanced idea tending toward development and progress; we place an abiding trust in your intelligence and sagacity, and earnestly hope that you will devote such far-reaching inquiry and consideration to this subject as will enable you to successfully cope with the question in all its bearings, that all its salient points shall stand revealed; for which this association shall reap its full measure of honor and credit.

I should be derelict in my duty, ungrateful to this association, and untrue to myself did I not publicly refer to my election as your President one year ago, an honor ever to be remembered by me with the most affectionate gratitude. The cares and labors of an active life, in a rapidly developing section, with a fast growing business over both mountain and plain, have demanded such unceasing attention that I fear my share of your work has not received that constant activity that should have been bestowed upon it; still I have faithfully endeavored to fulfill the trust you reposed in me. In all my correspondence with your committees and members, I have received the heartiest coöperation, and I am especially indebted to our Secretary for his valuable assistance.

To Mr. Angus Sinclair, mechanical engineer, well versed in theory and experienced in practice, educated in his profession and cultured as a gentleman, at one time speaking to us as an editor through the medium of the art preservative of arts, and now as Secretary of this Association, I now openly tender my grateful thanks, and close my address invoking upon your labors in this convention the fostering care of Divine Providence.

ROLL CALL.

Secretary Sinclair called the roll. The following members were present then or at a later session:

AGNEW, J. H. .... **South Carolina, Charleston, S. C.**
AMES, L. .... **Beech Creek, Jersey Shore, Pa.**
BARNETT, DAVIS J. .... **Grand Trunk, Stratford, Ont.**
BARR, J. N. .... C. M. & St. P., **Milwaukee, Wis.**
BATTYE, JOHN E. .... **Shenandoah Val., Milnes, Va.**
BEAN, JOHN .... C. & Canton, **Canton, Ohio.**

BECKERT, ANDREW	Louis. & Nashville, Decatur, Ala.
BISSET, JOHN	W. W. C. & A., Wilmington, N. C.
BLACK, JOHN	Lima, Ohio.
BLACKWELL, CHARLES	Schoenberger & Co., Pittsburgh, Pa.
BOATMAN, F. P.	Ohio & Miss., Vincennes, Ind.
BRADLEY, S. D.	G. R. & Ind., Grand Rapids, Mich.
BRIGGS, R. H.	K. C. M. & B., Memphis, Tenn.
BRYANT, J. T.	Rich. Fred. & Potomac, Richmond, Va.
BUSHNELL, R. W.	B. C. R. & N., Cedar Rapids, Ia.
CAMPBELL, JOHN	Lehigh Valley, Delano, Pa.
CARSON, M. T.	Mobile & Ohio, Jackson, Tenn.
CASEY, J. J.	L. N. O. & Texas, Vicksburg, Miss.
CHAPMAN, N. E.	251 S. 4th St., Philadelphia, Pa.
CLARK, DAVID	Lehigh Valley, Hazleton, Pa.
COOK, JOHN S.	Georgia, Augusta, Ga.
CORY, C. H.	C. H. & D., Lima, Ohio.
CROMWELL, A. J.	Baltimore & Ohio, Baltimore, Md.
DEIBERT, F. W.	Cin. J. & M., Marshall, Mich.
DIVINE, J. F.	W. & Weldon, Wilmington, N. C.
DOWNING, T.	E. Jol. & Eastern, Joliet, Ill.
ENNIS, W. C.	N. Y. S. & W., Wortendyke, N. J.
FENWICK, A.	G. B. W. & St. P., Green Bay, Wis.
FERGUSON, G. A.	Concord & Montreal, Lake Village, N. H.
FERGUSON, Z. J.	
FINLAY, L.	902 West 4th St., Little Rock, Ark.
FOSTER, W. A.	Fall Brook Coal Co., Corning, N. Y.
FULLER, WM.	213 Kennard St., Cleveland, Ohio.
GARRETT, H. D.	Pennsylvania, Philadelpnia, Pa.
GARSTANG, WM.	Ches. & Ohio, Richmond, Va.
GENTRY, T. W.	Richmond & Danville, Richmond, Va.
GESSLER, WM.	C. R. I. & P., Trenton, Mo.
GIBBS, A. W.	Richmond & Danville, Alexandria, Va.
GIBBS, GEORGE	C. M. & St. Paul, Milwaukee, Wis.
HALLER, W. J.	Ches. & Ohio, Richmond, Va.
HARDING, B. R.	R. G. R. & A., Raleigh, N. C.
HARRIS, GEORGE D.	Richmond & Danville, Salisbury, N. C.
HAZLEHURST, G. B.	Baltimore & Ohio, Baltimore, Md.
HASSMAN, WM.	Ches. & Ohio, Huntington, W. Va.
HEMPHILL, W. J.	Jacksonville South E., Jacksonville, Ill.
HICKEY, JOHN	M. W. S. & Western, Kaukauna, Wis.
HUDSON, E. E.	C. C. C. & St. Louis, Cleveland, Ohio.
HUGHES, E. W. M.	Rookery Building, Chicago, Ill.
JACKSON, O. H.	O. & Miss., Vincennes, Ind.
JENNINGS, WM.	Mexican Intern't'l, Piedras, Negras, Mex.
JOHANN, JACOB	608 Phœnix Bld'g, Chicago, Ill.

JOHNS, C. T.	Cleveland, Ohio.
LANNAN, WM.	House of Reps., Washington, D. C.
LEEDS, PULASKI	L. & Nashville, Louisville, Ky.
LEWIS, W. H.	D. L. & Western, Kingsland, N. J.
LEWIS, WILLIAM H.	C. B. & Northern, La Crosse, Wis.
LOSEY, JACOB	Steam Forge Co., Louisville, Ky.
LUTTGENS, H. A.	Rogers Loco. Works, Paterson, N. J.
LUTTRELL, J. W.	N. N. & Miss. Valley, Paducah, Ky.
MACKENZIE, JOHN	N. Y. C. & St. L., Cleveland, Ohio.
MAGLENN, JAS.	Carolina Central, Laurenburgh, N. C.
MANLY, BASIL	A. & N. C., Newberne, N. C.
MARSHALL, E. S.	St. L. A. & Tex., Pine Bluff, Ark.
McCREERY, FRANK	Dayton, Ft. Wayne & Ch., Dayton, O.
McCRUM, J. S.	K. C. Ft. S. & G., Kansas City, Mo.
McKENNA, JOHN	I. D. S., Indianapolis, Ind.
MEDWAY, JOHN	Fitchburg, Mechanicsville, N. Y.
MEEHAN, JAMES	C. N. O. & T. P., Ludlow, Ky.
MICHAEL, J. B.	E. T. V. & Ga., Knoxville, Tenn.
MILLS, STOTT	Lehigh & Hudson, Warwick, N. Y.
MILLEN, THOMAS	N. Y. City & N., High Bridge, N. Y.
MORRELL, J. E.	C. R. I. & P., Davenport, Ia.
NOBLE, L. C.	H. & T. C., Houston, Tex.
O'BRIEN, JOHN	Richmond & Petersburg, Manchester, Va.
PATTEE, J. O.	Great Northern, St. Paul, Minn.
PATTERSON, J. S.	Col. & Hock. Val., Columbus, Ohio.
PAXSON, L. B.	P. & Reading, Reading, Pa.
PECK, PETER H.	C. & W. I. & Balt., Chicago, Ill.
PITKIN, A. J.	Locomotive Works, Schenectady, N. Y.
PORTER, JOSEPH S.	C. S. & C., Sandusky, Ohio.
PURVIS, JR., T. B.	Boston & Albany, East Albany, N. Y.
QUINN, JOHN A.	C. V. & C., Mt. Carmel, Ill.
RANDOLPH, L. S.	Balt. & Ohio, Baltimore, Md.
RAYNAL, A. H.	Locomotive Wk's., Richmond, Va.
REYNOLDS, W. W.	C. St. L. & P., Columbus, Ohio.
RICHARDSON, E.	S. & Allegheny, Shenango, Pa.
RILEY, G. M. D.	San. Fla. & Western, Savannah, Ga.
ROBERTS, E. M.	E. T. V. & Ga., Atlanta, Ga.
RUTHERFORD, WM.	Florida Southern, Palatka, Fla.
SAVAGE, R. W.	St. L. Ark. & Tex., Tyler, Tex.
SETCHEL, J. H.	Cuba, N. Y.
SHORT, W. A.	O. & L. C., Malone, N. Y.
SILVIUS, E. T.	J. T. & K. W., Palatka, Fla.
SKINNER, H. M. C.	N. Y. Loco. Works, Rome, N. Y.
SMALL, H. J.	Southern Pacific, San Francisco, Cal.
SMITH, W. T.	N. News & Miss. Val., Lexington, Ky.

SPRAGUE, H. N.	Porter Loco. Works., Pittsburg, Pa.
STEPHENS, S. A.	Locomotive Works, Providence, R. I.
STEWART, O.	Fitchburg, Charleston, Mass.
STINARD, F. A.	8 Dickinson St., Paterson, N. J.
STONE, W. A.	L. E. & St. L., Huntingburg, Ind.
SWANSTON, WM.	C. St. L. & P., Indianapolis, Ind.
TANDY, H.	Brooks' Loco. Works., Dunkirk, N. Y.
THOMAS, C. F.	Central Georgia, Macon, Ga.
THOMAS, W. H.	E. T. V. & Ga., Knoxville, Tenn.
TURNER, CALVIN G.	Phil. Wil. & Balt., Wilmington, Del.
TURNER, L. H.	Pitt. & L. Erie, Chartiers, Pa.
TURREFF, W. F.	C. C. C. & St. L., Indianapolis, Ind.
ULMO, H. A.	C. & Savannah, Savannah, Ga.
WALKER, C. W.	S. & Roanoke, Portsmouth, Va.
WARREN, W. B.	2808 Lafayette Ave., St. Louis, Mo.
WEISGERBER, E. L.	B. & Ohio, Newark. Ohio.
WHITE, A. M.	Schenectady Loco. Wk's., Paterson, N. J.
WHITNEY, H. A.	Intercolonial, Moncton, N. B.
WIGHTMAN, D. A.	Pittsburgh Loco. Works, Allegheny, Pa.

ASSOCIATE MEMBERS.

BARNES, D. L.	Rookery Building, Chicago, Ill.
FORNEY, M. N.	145 Broadway, New York.
HILL, JOHN A.	96 Fulton St., New York.
POMEROY, L. R.	Suburban Rapid Transit Co., New York.
SINCLAIR, ANGUS	Morse Building, New York.
SMITH, JOHN Y.	Doylestown, Pa.
SMITH, W. A.	Rookery Building, Chicago, Ill.

THE PRESIDENT.—The next business in order is acting on the minutes of the last meeting.

SECRETARY SINCLAIR—Mr. President, you all have seen the minutes of the last meeting in the report published ten months ago, and as I do not suppose you wish to hear this report read, I would move that the minutes be accepted as published.

The motion was carried.

A recess of five minutes was taken for the purpose of admitting new members.

After the recess Secretary Sinclair read his report as follows:

SECRETARY'S REPORT.

According to your Secretary's Report, submitted a year ago, this Association consisted of 297 ordinary members, 13 associates and 12 honorary members, a total of 322. The number of mem-

bers on the roll at the opening of this Convention is 334 ordinary members; 15 associates and 14 honorary members, a total of 363, making a gain during the year of 41 members. The increase is considerably greater than the figures represent, for 18 members were dropped for non-payment of dues, 3 resigned and two ordinary members and one honorary member have died. On the death roll are the names of H. W. Burford, J. M. Sanborn and H. M. Britton. The latter honorary member, who, at the time of his death, was general manager of an important railroad, was one of the organizers of the Association. He was for many years a hard worker in the interests of the organization and was president for the longest time any one has held that office.

At the last Annual Convention three places, Chattanooga, Montreal and Buffalo were selected for the holding of this Convention, the final decision being left to the Executive Committee, as provided for in the Constitution. The greater number of votes favored Chattanooga, and your Executive Committee decided that the Convention should be held there. But it was subsequently discovered that the hotel, a new building, which was selected for the headquarters of the Convention was not finished, and the likelihood of its being in a condition to provide the necessary accommodations and comforts was so uncertain that your committee decided not to depend upon it. The Master Car Builders' Association had in the meantime decided to hold their Convention at Old Point Comfort. As it is well understood that many of our members are members of the Master Car Builders' Association and are in the habit of attending both meetings, your Committee did not wish to take the responsibility of holding the Convention at the distant point the selecting of any of the alternative places would have entailed, so they directed your Secretary to obtain by letter ballot a vote of the members on the place of meeting. This resulted in the selecting of Old Point Comfort, Va.

The Annual Report was prepared and sent out to members and subscribers within two months after last Convention was held. Sixteen hundred copies were printed and 1317 copies have been disposed of in various ways—to members, subscribers, newspapers, exchanges, libraries and by sales. There continues to be

frequent requests from libraries and scientific societies for sets of the Annual Reports and your Secretary has satisfied such requests. Report No. 6 is out of print and it appears desirable that a reprint should be made. There is also a demand for a codified index of the subjects treated in all the Annual Reports.

The financial condition of the Association continues to be very satisfactory. The funds necessary for carrying on the business have been collected readily, and has been a light tax on the members. Dues brought in $1,265, the Printing Fund $968 and the sale of Reports $33,50. In the preceding year the collections were: Dues, $1,493; Printing Fund, $942 ; and sale of Reports, $40. It will be seen that the receipts for dues were less last year than they were the preceding year. During the financial year 1888-9 the collection for dues were abnormally high, and were the result of a vigorous effort to collect dues that had fallen in arrears.

The following contribution has been received for the Printing Fund during the past year:

Alleghany Valley	$10 00
Atchison, Topeka & Santa Fè	10 00
Baltimore & Ohio	10 co
Boston & Albany	10 00
Brooks' Locomotive Works	25 00
Buffalo, Rochester & Pittsburgh	10 00
Burlington, Cedar Rapids & Northern	10 00
Burnham, Parry, Williams & Company	25 00
Central Georgia	10 00
Central Iowa	10 00
Central Vermont	10 00
Charleston & Savannah	10 00
Chesapeake & Ohio	10 00
Chicago & Northwestern	10 00
Chicago, Burlington & Northern	10 00
Chicago, Burlington & Quincy	10 00
Chicago & Alton	10 00
Chicago & Eastern Illinois	10 00

Chicago, Milwaukee & St. Paul	$10 00
Chicago, Rock Island & Pacific	10 00
Chicago, St. Paul & Kansas City	10 00
Chicago, St. Paul, Minneapolis & Omaha	10 00
Cincinnati, Hamilton & Dayton	10 00
Cincinnati, New Orleans & Texas Pacific	10 00
Cincinnati, Washington & Baltimore	10 00
Cleveland, Akron & Columbus	10 00
Cleveland, Cincinnati, Chicago & St. Louis	10 00
Colorado Midland	10 00
Connecticut River	10 00
Capiapo of Chili	10 00
Delaware & Hudson Canal	10 00
Delaware, Lackawanna & Western	10 00
Duluth, South Shore & Atlantic	10 00
Denver & Rio Grande	10 00
East Tennessee, Virginia & Georgia	20 00
Flint & Pere Marquette	10 00
Fitchburg	10 00
Grand Rapids & Indiana	10 00
Grand Trunk	10 00
Intercolonial	18 00
Kansas City, Fort Scott & Gulf	10 00
Lake Erie & Western	10 00
Lake Shore & Michigan Southern	15 00
Lehigh Valley	10 00
Louisville & Nashville	10 00
Louisville, New Orleans & Texas	10 00
Maine Central	10 00
Michigan Central	10 00
Midvale Steel Works	10 00
Minneapolis & St. Louis	10 00
Missouri Pacific	10 00
Mobile & Ohio	10 00
New York & New England	10 00
New York, Chicago & St. Louis	10 00
New York, Lake Erie & Western	20 00
New York, Ontario & Western	10 00

New York, Providence & Boston	$10 00
Nile's Tool Works	10 00
Norfolk & Western	10 00
Northern Pacific	10 00
Ohio & Mississippi	10 00
Old Colony	10 00
Pedrick & Ayer	10 00
Pennsylvania	10 00
Philadelphia & Reading	10 00
Philadelphia, Wilmington & Baltimore	10 00
Porter & Co	10 00
Prosser & Son	25 00
Raleigh & Gaston	10 00
Rhode Island Locomotive Works	10 00
Richmond & Danville	10 00
Rogers Locomotive Works	50 00
Rome, Watertown & Ogdensburg	10 00
St. Louis, Arkansas & Texas	10 00
St. Louis & San Francisco	10 00
St. Paul & Duluth	10 00
Schenectady Locomotive Works	10 00
Solid Steel Works	10 00
Southern Pacific	10 00
Terre Haute & Indianapolis	10 00
Toledo & Ohio Central	10 00
Wabash	10 00
Western Maryland	10 00
Western New York & Pennsylvania	10 00
Wilmington and Weldon	10 00
Total receipts from Printing Fund	$968 00
Receipts from dues	1,265 00
Receipts from sale of Reports	33 50
Grand Total	$2,266 50

ANGUS SINCLAIR, *Secretary.*

On motion the report of the Secretary was received.

TREASURER'S REPORT.

Secretary Sinclair read the Treasurer's report, as follows:

Cash on hand as per last report	$908 02	
Received from A. Sinclair, Secretary	2,266 50	
		$3,174 52
Paid Angus Sinclair, Secretary, salary	$1,200 00	
Collins, printing cards	1 75	
Belden & King, rent of Hall	30 00	
Reporting	154 25	
Benedict & Co., Engravers	48 70	
Atkins, for printing Committee reports	27 00	
Starr, printing circulars	8 00	
R. R. Donnelley & Sons, printing reports	474 00	
Insurance on reports	8 00	
McGowan & Slipper, printing circulars	40 75	
Expenses of Secretary's office	101 40	2,093 85
		$1,080 67

O. STEWART, *Treasurer.*

On motion the report was received.

SECRETARY SINCLAIR.—At the Executive Committee meeting held last night, a decision was come to that the dues for the current year be five dollars, and this is recommended to the Association. If some one will make a motion that five dollars be the dues for the current year, it will facilitate the business.

A motion to this effect was carried.

THE BOSTON FUND.

Mr. J. H. Setchel, Custodian of the Boston Fund, presented the report on the Fund as follows:

GENTLEMEN. Having been reappointed by you custodian of the Boston Fund, as provided in the constitution I respectfully beg leave to make the following report of the amount and condition of the same.

At date of last report, the principal in Government four per cent. bonds, was sixty-two hundred dollars *in bonds*, and not sixty-two hundred dollars, as might be understood from the

reading of the report, and an unexpended interest of two hundred and seventy dollars and thirteen cents ($270.13).

To this principal there was added the first of the year, two hundred dollar bonds at a cost of two hundred and forty-eight dollars ($248.00), thus increasing the principal to sixty-four hundred dollars in bonds, and leaving an uninvested balance of last year's interest of twenty-two dollars and thirteen cents ($22.13), giving the statement at present time as follows:

Four per cent. Government Bonds	$6,400 00
Interest for one year	256 00
Balance from last year's interest	22 13
Total uninvested, interest	$278 13

Respectfully,
J. H. SETCHEL,
Custodian of Boston Fund.

On motion the report was accepted.

ELECTION OF OFFICERS BY BALLOT.

THE PRESIDENT.—Article 8, Section 1 of the Constitution reads as follows:

"At the first session of the Annual Meeting, the President shall appoint a Nominating Committee of five members who are not officers of the Association, and this Committee shall send the names of nominees for offices of the Association to fill vacancies for the ensuing year, to the Secretary before the election of officers is in order, and they shall be announced by him as soon as received. The election shall not be held until the day after such announcement, except by unanimous consent. Any three members may nominate candidates for any office."

MR. SETCHEL—I ask unanimous consent to introduce a resolution at this time before that appointment is made.

On motion the permission asked for, was granted.

MR. SETCHEL—Mr. President: I think every member of this Association will believe me when I say that I have received all the honors that it is possible for this Association to give. For twenty years it has been my right and my privilege to sit upon that platform as an officer of this organization, and I assure you that fact has given me great pleasure as well as great honor, so that in presenting the resolution that I have, it is no new thing with me. I advocated it when this Constitution was made, and I had previously advocated it in every case of an election that has taken place in this Association. If the members wanted me to serve them, I wanted them to elect me spon-

taneously and not because a committee reported my name. I have always taken this stand. You will remember, that two years ago Mr. Lauder gave notice that at the next Annual Meeting he would introduce a resolution as an amendment to the Constitution, providing that officers should be elected annually by ballot without any nomination. This, it seems to me, gives every member of this Association courage to work and to act for whatever there may be in the future, without thinking when he comes here that there are three, four or five men ahead of him, and there is no use of his trying to aspire to any position. Take for instance, the Presidency. He may say to himself, "It will take six or eight years at any rate before I can fill that position when this routine is gone through, and then I may be farther behind than I am now." Now, it seems to me the privilege of every American citizen to vote for whomsoever he pleases, and then when an officer is elected every member of the Association feels satisfied. He feels that the officers haven't been set up by any Committee, and that it is the desire of the Association that such an officer shall serve them, and everything is just as it should be; and for that reason, Mr. President, I beg leave to offer the following resolution:

Resolved, That the words "without nomination" be inserted in Article 7 of the Constitution after the words "the officers of the Association shall be elected by ballot separately," and all other sections inconsistent therewith be and are hereby repealed.

I move the adoption, Mr. President, of that resolution.

The motion was seconded.

MR. M. N. FORNEY—I would rise to dissent from my friend Mr. Setchel with a good deal of reluctance. But it seems to me there are some objections to the resolution as he has presented it. Some years ago, at the time the Constitution of the Car Builders' Association was revised, the whole question was brought up and considered at great length and with a great deal of care, and by some other members of the committee, I may say, with a great deal of ability, and this difficulty presented itself—In case there is no nominating committee appointed, when the time arrives for the election of officers, it is found that there are no nominations and nobody has thought about that. It has been nobody's business. The result is there are no nominations, and an election is held and members vote for officers and vote, to a very great extent, at random. Now, at the time we revised the Constitution of the Master Car Builders' Association, a provision, substantially the same as exists here, was inserted—that a nominating committee should be appointed whose business it should be to nominate officers so that there would be nominations before the Association. Then, in order to give the widest liberty to members in regard to a selection, it was provided that any three other members might make nominations. Now, surely no greater liberty can be given n an association for the election of officers, than to say that any three members might make other nominations. If, however, there is no provision for a n ominating committee, the time for your election will come around and there

will be no nominations, and then there will be a mere selection at random. With the provision as it stands in the Constitution at the present time, after the regular nominating committee have presented their nominations, then any other three men may make nominations, which is surely giving as much liberty as is required to afford a fair representation. To show how that operates. Some years ago there were in our sister association some differences of opinion about the election of officers. There was a good deal of excitement, and a number of gentlemen made and presented an opposition ticket. Part of that ticket was elected and part of the regular ticket was elected. If any three members of the Association are not satisfied with the nominations of the regular committee, they are at liberty to bring in an opposition ticket at any time. I think the amendment will hardly be an improvement in the Constitution, and hardly to the interest of the Association.

MR. SETCHEL—In answer to my friend Forney, I should like to ask him a question—how he gets at the sense of what would be acceptable officers to the Association. I will wait for a reply.

MR. FORNEY—I think it comes up this way: The regular nominating committee is appointed, They present their nominations. Now, after those nominations are read, if there are any members in the Association who think the nominations are not acceptable, they are at liberty to introduce other nominations.

MR. SETCHEL—Is not this the fact: The nominating committee pass around among the members and say, "Whom do you want to have for Secretary?" "Well, I think Mr. Sinclair has made an excellent man." "But don't you think somebody else would do better?" And he brings his arguments up, and the member says, "I believe I will agree with you." Does he get at the sentiments of that man? Not at all. The man wants Mr. Sinclair.

MR. MACKENZIE—The man doesn't know his own sentiments.

MR. SETCHEL—He simply has been hauled over by the man who talks to him. This is the way elections are carried in wards. I know something about that myself, and we ought not to have anything of the kind here. But if by a secret ballot twenty-five men vote for Mr. Sinclair on the first ballot and there are only thirty members voting. why we see at once that Mr. Sinclair is the man, and the others all fall in. They get in that way the sentiment of the Convention and not the sentiment of the Committee, as my friend, Mr. Forney, has stated. (Applause.) If we want to get at the sentiment of the members of this Convention, let a man write down his preference and put it in a hat. Then we will know whom he wants for President, Vice-President, Secretary or any other officer of the Association. But if we have to go around log-rolling, we do not get the sense of the Convention. Now, is not that true, Mr. President? My friend Forney says that he wants the best members, which is all right. Who is to judge? The man who has the most skill in log-rolling and persuading Tom, Dick and Harry to nominate such a man? Is that the way to get at

the sentiment of the Convention? I think not. But let him write down his preference; then we know whom the Convention wants. (Applause.)

MR. H. N. SPRAGUE—I understand that we want a President elected by the majority. I do not understand there is any provision made in that for dropping desultory candidates. And it seems to me one point in that would be the taking of more time than we can afford. If there is any such resolution as that passed, it ought to be understood that all but the three highest candidates should be dropped on the second ballot. If each little faction has its own favorite they will vote here all day on their favorites, and the result will be we shall have no election.

MR. SETCHEL—I do not think it is possible for any such thing as that to occur. If there are any two or three members, or half a dozen members, who feel they want some man for President whom nine-tenths of the others do not want, I have no fear of such a minority standing out any time at all. We are all good, true, democratic citizens, and when we see that the majority wants such a man for President, Secretary or any other officer, we will certainly yield the point.

MR. FORNEY—I would just like to say one word. I hope I will not be considered as in any way looking out for an office. because it is known that I am an associate member and am not eligible for office. I remember, though, that last year the question of a place of meeting—

MR. SETCHEL—Will the gentleman allow me to interrupt him?

MR. FORNEY—Certainly.

MR. SETCHEL—The gentleman says he is not eligible for office, because he is an associate member. Our present Secretary is an associate member. Mr. Forney became Secretary of the Master Car Builders' Association by being an associate member, and therefore I think he is quite in the line.

MR. FORNEY—Well, I do not want it. I resign any office in anticipation of it. At the meeting last year the question of a place of meeting came up in the Car Builders' Association. Some gentleman got up and proposed that we meet in Charleston, I believe. In the Master Mechanics' Association I think some one proposed Chattanooga. In neither case had any one looked into the matter. It was found that it would be totally impracticable to meet at those places. I think the same thing will arise if you have no nominations before the election comes up—that there will be no proper officers to vote for. That is my only reason for having spoken to Mr. Setchel's resolution.

THE PRESIDENT—All in favor of the resolution as read by Mr. Setchel will please make it known by rising to their feet—those opposed in the same way.

The resolution was carried.

AUDITING COMMITTEE.

The President—The next order of business is the election of an Auditing Committee. I will appoint Mr. Sprague and Mr. Johann as tellers.

Mr. Setchel—I nominate for that Committee, J. Davis Barnett, William Swanston and R. W. Bushnell.

Mr. Peck—I move that Mr. Johann cast the ballot.

The motion was carried.

Mr. Johann—This is a little embarrassing to me. In the first place, you say that your Committee shall be elected by ballot, and then you say somebody else shall cast your ballot. I see no reason why the chairman should not appoint the Committee. However, as the resolution has been passed, I take pleasure in casting the ballot of the Association for J. Davis Barnett, William Swanston and R. W. Bushnell.

PROPOSED DISPOSAL OF BOSTON FUND.

The President—We will now proceed to new business.

Mr. Setchel—All those who are present and heard the report on the Boston Fund, will at once see the drift of this resolution. I beg leave to offer the following resolution :

Resolved, By the American Railway Master Mechanics' Association in convention assembled, that a committee of three members, consisting of J. N. Lauder, John N. Barr and Angus Sinclair, be, and are hereby appointed, empowered and directed to confer with the Trustees or other proper officers of the Massachusetts School of Technology, of Boston, and the Cornell University of Ithica, New York, and arrange and report a plan at our next annual meeting, for the investment of the principal and interest of the Boston Fund of this Association, in one or more scholarships in one or both of those Institutions, and submit the same for the approval of the Association; the benefits of said scholarships to be given for such time as may be directed by the Association as a prize to the sons of members who shall exhibit the most valuable attainments and skill in the development of locomotive mechanics; and be it further

Resolved, That notice is hereby given that a vote will be taken at our twenty-fourth annual meeting to so appropriate said Fund.

Mr. President—I move the adoption of the resolution.

Mr. Johann—I second that motion.

The President—You are aware that this is an amendment to the Constitution. It cannot be voted upon until next year.

Mr. Setchel—It is not an amendment. It is simply a notice that next year the amendment will be asked for. Now, Mr. President, I move the adoption of this resolution which does not make an amendment to the Constitution. It simply provides that at our next annual meeting this shall be voted on. We cannot appropriate any part of the Boston Fund except by a year's notice, and in order to do that at the next annual meeting a notice must be given at this.

Now, it is entirely in order and proper to appoint such a committee to make arrangements such as they should think best to carry out the idea of the resolution, and report it at our next annual meeting. That is all the resolution carries—that this committee should report a plan, and then at our next annual meeting we can legally vote as to whether we will do it or not. That is the entire scope of the resolution at present.

THE PRESIDENT—I understand you, Mr. Setchel, that this committee is merely a Committee of Inquiry to see whether this arrangement can be made that you suggest.

MR. SETCHEL—That is all, sir. I would simply state, however, that I wrote to the President of the Massachusetts Institute of Technology, asking if an arrangement could be made and he stated substantially that an arrangement of that kind could be made.

MR. GEORGE GIBBS—I would move that the Stevens' Institute of Technology be added to that list.

MR. SETCHEL—I accept that amendment—to include the Stevens' Institute of Technology.

The motion was then put to the meeting and carried.

THE PRESIDENT—Gentlemen, we have arrived at the noon hour, and you are aware that we now discuss promiscuous subjects.

THE BEST METHODS OF FITTING BOLTS.

SECRETARY SINCLAIR—The first subject that I have received for discussion is the method of fitting bolts, by James Meehan. He will introduce the subject.

MR. JAMES MEEHAN—Mr. President: I am a very poor hand at opening anything. Mr. Sinclair asked me for a subject and I suggested this one, as we found that a little reform in the old method begot considerable economy. The old method of fitting bolts to reamed holes in a great many repair shops, was to have the lathe man who does the turning, fit them to the reamed hole. This proved to us to be very expensive, and we adopted a method of gauges and calipers to expedite and cheapen this class of work. Our calipers are case-hardened and ground out, varying one-hundreth part of an inch. We use straight holes in engine truck frames, and various other classes of work where wrought iron braces are bolted together, we finding that the straight holes where bolts were to remain permanent, were in a great many cases the most substantial.

When the holes are reamed, the man who turns the bolts is furnished with calipers to turn the bolt by, which always conforms to the reamer, and which is neatly calculated to drive with a hand hammer of four, six, eight or ten pounds, as the necessity of the case demands. All rod bolts, cylinder saddle bolts, or other bolts of this nature, are made to taper one-sixteenth inch to the foot. We have a system of cast iron gauges to suit the taper reamer. The gauge is made in the form of a bush and reamed out to the various lengths of

the reamer. When the hole is reamed, the gauge is selected to correspond with the size of the hole, and left on the lathe where the bolts are turned, with instructions to give them one-fourth or three eighth draft as the case may demand. The man fitting the bolts can see at a glance whether the bolt is perfect in conformity with the reamed hole in the gauge, by dropping the bolt into the gauge. By this method bolts can be driven in the same manner as a straight bolt, thereby avoiding the necessity of the bolt turner calipering the hole and fitting the bolt thereto, in the ordinary way. This method has been instrumental in saving us a great deal of expense and trouble in this class of work.

THE PRESIDENT—We would like to hear from some of our friends engaged in the manufacturing of locomotives. We would like to know what their method is. Can Mr. Sprague enlighten us?

MR. SPRAGUE—I never have found any perfect way of doing that kind of work. I do not pretend to fit a bolt to a hole. I ream steel dies one and one-half or two inches thick and drive the bolts into them, and then put them in the rack. When we come to fitting them we drive them into the place in the work. Sometimes we find them too large and then we file them down a little. Except in connecting rods, I use straight bolts altogether. After we accumulate any number of bolts that are too loose for a driving fit, we use them for loose bolts and we also change our reamers as the case may be. I do not know but somebody has got to mechanical perfection in these matters, but I never have. I never have found a reamer yet that would not wear, and while I believe I keep as close to standards as anybody, I do not pretend to duplicate a driving fit. I do not know whether anybody else does or not.

THE PRESIDENT—Can we hear from Mr. Pitkin of the Schenectady Locomotive Works in regard to their practice?

MR. A. J. PITKIN—We have cast iron gauges for reaming to a fit, reaming to a standard size, and the bolts are all fitted to this. The holes in the work are reamed and the bolts driven without any fitting whatever. We scarcely use any straight bolts.

THE PRESIDENT—I would like to know something about the practice on the Pacific coast. Will not Mr. Small be kind enough to give us his practice?

MR. H. J. SMALL—I do not know that we differ very much from our brethren East in these matters. We taper fits generally in bolt fitting. We have done considerable engine building at our shops. We built eighteen new engines, and in all of them we used bolts made to gauge.

I presume it is the almost universal practice in railroad repair shops to ream a hole and then fit the bolt to it. We probably differ from the builders in that respect. Perhaps we would do the same as they do if we were building engines by wholesale.

MR. PULASKI LEEDS—I would like to know how many of us there are who use straight bolts for straight holes. I have always found that there was a slight taper to them, almost universally. For a good many years I have made a practice of taking every bolt from the blacksmith's shop roughing it out and

turning it down to the size of the thread, and cutting the thread in the bolt cutter, as I have found with manufacturers generally the fit was on top of the thread, on the burr, and after running a little while the nuts were very loose. By cutting them in a four die bolt cutter, I found that I got a perfect thread and the nuts would always be tight. I then put these bolts away, and when they are ready for fitting we run the finishing cut over them, and fit almost always to ring gauges and invariably with a slight taper.

I have adopted that universally for the very reason that a great many of our holes are through wrought iron and cast iron. Any reamer I ever saw yet will ream larger in cast iron after passing through wrought iron, or reversing it and passing the reamer from cast iron into wrought iron. This is especially apparent in bolting on cylinders. I think almost all of us have had to rebolt cylinders whether they were fitted by ring gauge, snap gauge or by caliper. We drive our bolts through wrought iron first and then into the cast iron. We have a larger bearing in cast iron than in wrought iron and can afford to stretch the sheets in driving bolts.

I have a light taper on my bolts and I adopted the same thing on my crank pins. I always found with a manufacturer's fit or a home-made fit, either, for that matter, that in every crank pin I ever took out, unless it was fitted on a taper, it had a bearing on the point, on the inside of the wheel where it did no good, and outside the pin would always work. Of course there are a great many theories advanced that the working strain on the rod will compress the grain of the iron in the outside of the hub, and consequently make the hole oblong and thus make it loose. But I found by advancing the taper for two inches before reaching the collar on the crank pin so as to increase the pressure some ten tons in putting in all, that pins coming out of such a hole after long service, (taken out because I thought the fatigue of the metal had carried it beyond the point where it was safe) were universally tight.

I do not think it is beyond the range of possibilities to fit any number of bolts, and ream any number of holes so there will be very few of them that will not go, as Brother Meehan says, with a four or an eight pound sledge. There is quite a great variation in the blow. At the same time I think they will come near enough to uniformity so that they can be turned if the gauges are properly adjusted to the reamers.

My practice has been to buy my standard reamers absolutely to the size. As they get dull I run an emery wheel over them and I have gauges to which those reamers are reduced every time; the inch reamer is reduced to a scant sixty-fourth or a sixty-fourth exact. I understand that a great many take exception to the word "scant." I have gauges that fit that reamer, and I have had very little trouble on account of loose bolts through cast iron and wrought iron, or wrought iron and cast iron, or directly through one metal in two pieces.

My rods I fit together with taper bolts, and every rod is reamed under a drill press. I find that I can size these holes so perfectly that I can carry a stock of bolts that are fitted to gauges and with one-eighth of an inch taper to

the foot, I never have to touch the bolts. If I want one on any of the engines for roundhouse repairs or new work, I can pick up a bolt and put it in and it will come so close to the same size every time, that I have no trouble in putting it in and utilizing it. You understand, gentlemen, by taper I do not mean anything more than just barely an appreciable taper. But as to driving a straight bolt into a straight hole, I never saw one fit yet. If it did it was an accident. Probably all of you have noticed, in cases of driving axles pressed on and then from some cause taken off, that where there has been a straight fit, the tool marks were all smoothed out for two or three inches on the end, while the rest showed no signs of having filled the hole. I think this could reasonably be expected, as the wrought iron axle is not compressed to any appreciable degree; while the opened grained cast iron is forced into a greater density, just the same as any metal, under a blow or great pressure will yield and set, and there being but slight elasticity to cast iron, it does not contract after being displaced on the same principle that the dent remains after the blow.

A gentleman asks me if I have an established taper for my crank pins. I will answer that in the last two inches of the fit I raise the pressure about ten tons from what it was put in the rest of the length of the fit. That is something that I do not very often give as measurements to my men, as they take their fits by the daylight under the caliper.

MR. H. A. LUTTGENS—In connection with tapering holes I use tapered plugs. The plug is inserted in the hole, and it is carefully noted how far it goes in. In the same plug is inserted another hole. In that way the fit can be made exact.

MR. J. S. McCRUM—I would like to ask Mr. Leeds at about what pressure he puts on a crank pin say for a consolidation engine, which would be about six and one-half to seven inches long.

MR. LEEDS—Nothing less than sixty-five tons and nothing over eighty tons. That is on the main pin, you understand.

MR. McCRUM—My practice has always been to make parallel fits for crank-pins, and I recognize the fact that the taper fit is the best. Any other taper fit is better than any parallel fit that can possibly be got, from the fact that it is reasonable to assume that the first portion of the bolt does change the character or size of the hole somewhat. Consequently, as has been said, it would fit tighter on the point.

MR. LEEDS—May I have the privilege of calling up Mr. Swanston and asking him one question? He made the point with me that some of his men blundered, and got driving-wheels on with a heavy counter-balance on one axle and a light one on the other, and he had to take them off, and found he could interchange the wheels. He was giving this as an illustration. I would like to ask him if the fit on his axle was turned perfectly parallel, and if he pressed those wheels in at any pressure he was of a mind to; in that way compressing the metal in his hubs as the axle went in. I would ask if when he bored those axles out he didn't find that the entire bearing of his axle was on the first three or four inches of the end of the axle leaving the the rest of it

in the hole, to such an extent that it did not rub the tool marks out on the rest of the axle.

MR. WILLIAM SWANSTON—The matter that Mr. Leeds referred to was a case in which the blunder occurred a couple of years ago in our shop in which they put a forward and a back wheel on the same axle. It went out and of course it didn't act very well, and we took it in and took the wheels off. We changed them around and then pressed them on. The wheels originally went on with something like forty-five or fifty tons pressure. The second one went on with about forty or forty-two or forty-three tons pressure and the other went on with twenty-five. Our wheels are bored as straight as the ordinary borer will bore, and we usually make the wheel seat with a little bit of taper, for the very reason Mr. Leeds speaks of, our wheels always pressing up increase in the force required as they go on. They will do that anyhow if they are perfectly straight. But we endeavor to increase the size somewhat to make that kind of fit that he speaks of. In the case of those axles I did not see them. I am not positive as to how the axles look. But I have seen a great many taken off that were fitted in that way and fitted the whole distance. I am perfectly satisfied, however, that in the case of bolts or crank pins or axles, that a perfectly tight fit cannot be made with a straight bolt. I have used taper bolts for all such work. In boring cylinders, where you have got to go from the wrought iron into the cast iron, it is simply impossible to make a straight bolt tight in the cast iron. Hence the necessity for a taper. We use the plug and hollow reamer. It is an easy matter—we simply drop them in until they come to a certain distance, and with that amount of taper we have the kind of fit that we want.

MR. MCCRUM—Referring to the matter of parallel fits and taper fits, and I should have added that, of course, I think the fact of the tightness of the bolt depends largely upon whether it is a smooth hole or whether it is a rough one. If the hole is perfectly smooth the straight bolt will necessarily be a much more perfect fit when it is driven home than it would be if it were a rough hole, with loose metal to give way. In one case there will be a film, as it were, and in the other case you would have the solid body as an impact, and I do not think that there is any question but that the taper is better than the parallel fit.

THE PRESIDENT—If there is nothing more to be said, gentlemen, the subject will be closed.

IS IT SAFE TO RUN A PONY TRUCK UNDER THE FRONT END OF FAST EXPRESS TRAIN ENGINES?

SECRETARY SINCLAIR—The next subject is, "Is it Safe to Run a Pony Truck Under the Front End of Fast Express Train Engines?" The question is presented by Mr. M. N. Forney.

MR. FORNEY—My only object in presenting this was the fact that I find it discussed on different roads now. They are building heavy ten-wheel

engines and heavy mogul engines for running express trains. Sometime ago I was making a design for a locomotive on paper, and it would have been very much more convenient to have used a pony truck in front than to have used a four-wheel truck. But I found that some parties objected to a pony truck as being unsafe at high speeds, and for that reason I proposed the question here to get at the experience of the gentlemen present who have better opportunities of observation out on their roads than I have in my office; and I should like very much if there could be a very general expression of opinion in reference thereto. Of course it is true that mogul and consolidation engines with pony trucks in front are used very generally throughout the country and for freight purposes, and it must naturally follow that in many cases those engines have to run at high rates of speed, and if there is any danger in running such engines at high rates of speed it should be shown in freight service as well as it would be in passenger service, and I think it is a subject that the members here present are better able to speak about than anybody else in the country.

MR. W. J. HEMPHILL—Some years ago I had charge of the rolling stock on a line where all locomotives were mogul narrow gauge engines. On one occasion a Brooks engine with a forty-two-inch wheel made 210 miles in six hours and thirty minutes. That is the best long distance run that I know of.

MR. E. M. ROBERTS—I have been for many years very partial to mogul engines, and I have often wondered why they were not more extensively used. Since a boy I have been raised on them, and I never knew of any trouble or of any accident caused by the pony truck of an engine. There is every argument in favor of the design and construction of mogul engines. The distribution of wheel base is better for carrying the weight. You take 100,000 pounds on your drivers and subtract 14,000 or 13,500—14,000 is the usual practice I presume; and you have with that 100,000 pounds an available weight on your drivers of 86,000 pounds. Now, with a ten-wheel engine with 34,000 pounds or thereabouts you would require to have 112,000 pounds to get a weight on your drivers of 78,000 pounds. Now, they are running, I think, on the Michigan Central, mogul engines on passenger trains very successfully.

MR. CROMWELL—I have had a great deal of experience with those engines and I never have had any trouble. It is claimed that there is some flange wear. That, perhaps, is true. The flange wear on the front pair of drivers in some instances may be a little more than it can be in a ten-wheel engine. But with the road with which I am associated, which is very crooked, I do not know whether that would apply in all cases or not. It is important that the arrangement of the trucks should be square and properly built. I have always been partial to the ten-wheel engine, and I would like to hear an expression from the members as to why a ten-wheel engine is preferred to a mogul.

MR. MCCRUM—This is a question that I think is a very important one

indeed, and I would like to hear the sense of this Convention on this subject. But with me the important feature is the question of the road, when you come to consider the matter of ten-wheel versus mogul engines, and I would like to know something about the character of the road as to the radius of the curves, etc., on which he has had experience with his mogul engines. If there is any one here representing the East Tennessee, Virginia & Georgia Road I would like to know whether or not at one time, some seven or eight years ago, there was not a test made on that line of the relative efficiency of two engines built by the same builder, mogul and consolidated type, the same size cylinders, for the purpose of determining whether or not the mogul engine did not lose by the friction in the curves more than it gained by the additional weight on the drivers over the ten-wheel engine. Now, for myself, individually, I never have had the opportunity of making these tests, but I do think that is a very important thing. The question as to the relative safety of the ten-wheel and mogul engine for high speeds is also a very important one. Not having had any experience with mogul engines particularly I do not care to venture an opinion.

Mr Setchel—This to me is a very interesting subject, and it is one on which I am often called upon to give an opinion. I think that nothing more important can be introduced at this time in the Convention than that very question. Not long since, I went into the General Manager's office upon a Western road and he asked the question, "What are you building for heavy passenger service?" I said to him, "I think the coming engine is the ten-wheel engine." He said, "What argument can you bring against the mogul engine?' I said to him, "Mr. General Manager, there is no argument you can possibly bring to show why the weight should not be made available as we do in a mogul engine for freight service, but it seems to me for a high speed passenger train, where the safety of lives is involved that the extraordinary caution which we should all observe under such circumstances would lead us to use a four-wheel truck instead of a two-wheel truck." He again asked the question, "What element of danger is there about a single pair of wheels?" It was then my turn to question. "I asked him the object of the truck—the single pair even." He answered, "To guide the engine." "Well," I said, "have you noticed in your experience that the single pair cuts the flanges more than the four-wheel truck?" Yes, he thought it did. "Well, doesn't it show then that the service, the work that the single pair has to do is greater than when distributed upon four wheels?" Well, yes, he thought it did. He had to acknowledge that he thought that was the case. Then I said to him, "There is one more point. Of course it is a question that I am not called upon to decide, and yet there, perhaps, might be cases where the Court will ask the question of mechanical men. Do you believe that a mogul truck is as safe running at high speed as a four-wheel truck?" I think that every Master Mechanic, if he would answer that satisfactorily to himself and the Court, would be obliged to say, that he did not think so. Well, there is a point involved that it seems to me, it is necessary to keep silent about. I have

never known any trouble with a mogul truck running at high speed, but there is a reason for that. I think that if we had been running mogul engines a few years ago at the high rate of speed that they are now being run, when we were using a different chair, when we were using a different rail, when our track was not as well surfaced as now, we would have been very apt to develop some bad accidents. But the fact is now, that our tracks are in such perfect order that it is almost impossible for the front end of an engine to leave the rails. But I think it is the experience of all that there is more wear upon a single pair of wheels than there is on four wheels, and that shows that it is subjected to greater work. True, we see it at once. There is only the two pair of wheels, and we remove them as soon as there is any possibility of danger. But that doesn't prevent a bad joint and running at high speeds. It seems to me, there is more danger with a single pair than with a four-wheel truck, and in running passenger service it seems to me that it is our duty to provide the greatest degree of safety for passenger engines.

MR. L. R. POMEROY—I would like to ask whether the excessive flange wear is attributable altogether to the pony truck—whether the radius bar does not cut some figure.

MR. SETCHEL—I will answer the gentleman by saying that the excessive flange wear of the four-wheel truck or of any truck or any driver is due to some mechanical imperfection; whether that exists in the two wheels or the four wheels it is all the same.

MR. JOHN MACKENZIE—My experience is that the mogul engine is all right, if we do not get the rigid wheel base too long, and I find that an addition of six inches has made a good deal of trouble in the flange wear, and we do not hesitate to run our moguls at any speed, but we do find difficulty in getting on side tracks with them. With our ten-wheelers we do not find that difficulty, and we have about come to the conclusion, or at least I have, that if we could shorten up the wheel base on our mogul engines to say fourteen feet, we would get equally good results as we do with the ten-wheel engine. When we went out to the sixteen feet we had too much rigid wheel base and the results were not good—in fact they were so bad, that the front wheels were removed after less than 20,000 miles on account of flange wear.

MR. CHARLES BLACKWELL—If there is a representative of the C. B. & Q. Railroad here perhaps he can give us some valuable information. The mogul engine has been the standard passenger engine, I believe, on that road for the last twelve or eighteen months and they run their trains at very high speeds. If there is no representative of the C. B. & Q., here, there is some representative from a parallel road.

MR. McCRUM—I would like to ask Mr. Mackenzie in reference to the length of wheel base on the mogul engine.

MR. MACKENZIE—Fifteen feet six inches.

MR. McCRUM—Assuming that you reduce the wheel base fourteen feet you have very little in excess of what you get on the modern ten-wheel engine. The question then naturally arises, do you find enough additional weight to

afford to take any chances between the truck and the point of the wheel. That is a matter I think worth considering.

MR. FORNEY—I hope the members will confine their remarks in this discussion to the subject involved in the question, which is as to whether a pony truck is safe at high speed. It is not the question of the relative merits of the mogul or ten-wheel engine for freight service, but, is the pony truck safe at high speed? I will add, as I am on my feet, if any member knows of a case of an engine leaving the rails from the use of the pony truck at high speed, I wish he would relate it. If nobody does know of any such case of an engine with a pony truck in front running off at a high speed it seems to me pretty strong evidence that the pony truck is safe.

MR. SPRAGUE—Of course we have built the two-wheel truck almost exclusively under our class of engines. Now, we are not building engines for high speed; but I have, during the narrow gauge mania, built a good many engines that ran pretty fast, and we build them not only with a two-wheel truck, but we build them with a two-wheel truck in place of a four-wheel truck. We built an eight-wheel passenger engine with a pony truck instead of a four-wheel truck. They were so well liked by the Master Mechanic that when he came to want heavier engines than that he would not have any other class of engine. We built 13x8 inch cylinders the same as the standard American eight-wheel engine with one pair of pony wheels forward of the cylinder. And he said with his experience on the Cairo & St. Louis road that none of those engines ever went off the track except they went off the end. Our experience now is largely with back truck. Those engines as a rule run both ways, and in all my experience with those engines I have never learned of any case of their going off the track where it was the fault of the truck, and I am so thoroughly convinced that they are perfectly safe that I would just as soon trust them as the four-wheel truck. If the four-wheel truck is safer and anybody can demonstrate it, we had better stick to it.

MR. L. FINLAY—I have used the engines that Mr. Sprague has just referred to. I was Master Mechanic of the Hot Springs road for over six years. The grades are very heavy on that road, running up to six per cent. and our prevailing curve at one time was a sixteen degree curve, and during all those years I never had a wheel to leave the track. It was a common practice with us when behind time making connection with the Iron Mountain, to run twenty-two miles in forty-five minutes, with our pony truck, and the four driving wheels under the engine. A more successfully working engine I never had experience with.

THE PRESIDENT—Will not Mr. Barr, of the Chicago, Milwaukee & St. Paul give us some of his experience?

MR. J. N. BARR—I could only say that I have had no experience with pony trucks whatever. The question proposed with reference to pony trucks is limited to their safety. As Mr. Forney says, that question ought to be settled by experience, if there are enough pony trucks running to settle the

question. I think there are other questions that are fully as important as deciding whether pony trucks or four-wheel trucks should be used.

MR. D. L. BARNES—As there is no representative of the C. B. & Q., present I would say, that for two years past that road has been using for passenger trains a mogul engine with a short wheel base. Those engines run the fast express trains and also the fast freight. I think the wheel base is fourteen feet. The passenger engines and freight engines are pooled. An engine goes west on a passenger train and may return on a freight train. To my knowledge there has never been an accident to that engine caused by the truck leaving the track. The truck has left the track on sidings, causing no accident. But that has been the result of the method of hanging the truck—not the radius bar. It was found that by hanging the truck and supporting the links at the bottom that too much lateral resistance was offered and that when that lateral resistance was properly adjusted no difficulty was met with. Having had such good experience with them they have adopted the pony truck for the Forney type of engine, which was their standard for the class I in suburban service. Those engines make forty miles an hour between stations. On the Illinois Central road they have engines of that type with a leading truck. They run probably more trains than any other suburban road in this country, and I never heard of an accident with a pony truck on that road.

MR. PITKIN asked if moguls were satisfactory on the C. B. & Q., why it was that the company were asking for bids to build ten-wheel engines?

MR. BARNES—I think I can answer Mr. Pitkin's question. There is one division of the Burlington road in the West where the man in charge is prejudiced. That is the reason they call for this engine—to satisfy the preference of that particular Master Mechanic.

MR. MACKENZIE—I rise to ask on behalf of Mr. Forney if there is anyone in the room who has known of a pony truck leaving the track at high speed.

SECRETARY SINCLAIR—I have known of several cases in the early days of moguls. I have paid a great deal of attention to this subject. I remember of two cases where accidents happened through the pony truck jumping the track. But the cause of it was attributed to a badly designed radius bar. In fact the length of the bar was entirely wrong, as that is now recognized, and the engines were all changed to comply with other conditions and afterwards there was no trouble with the engines leaving the track. It seems to me that a great deal of prejudice exists against the pony truck based on no real mechanical objections.

MR. FORNEY—Allow me to ask if those trucks were equalized with an equalizing bar with the front drivers?

SECRETARY SINCLAIR—I don't remember. I do not know any more of the details of the construction. It seems to me that the trouble experienced with engines that had badly designed pony trucks aroused prejudices that have not worn out until now, and that a great many prejudices against mogul engines are entirely sentimental. I cannot see that a well-designed pony truck is any

different from the English engines that are used today with an ordinary pair of front carrying wheels. I have run on those engines at the highest speeds that were common there in early days. There was never any doubt expressed about the safety of those engines, and I do not think that there is any more doubt about the safety of a carefully constructed mogul than there is of those with a front carrying truck.

THE PRESIDENT—The hour has expired, gentlemen, for the discussion.

MR. FORNEY—May I be allowed to make a motion that this subject be continued tomorrow?

MR. LEEDS—May I offer an amendment to that? That is, to ask Mr. Forney to make his motion that this subject be discussed in regular order, and that he withdraw his specification confining us to the safety of the truck. This is a very important thing. Although I have been a member of the Association for twelve years, this is the first time that I have been able to be here. I like to discuss these matters, and by advancing ideas that may be simple, perhaps, bring out ideas that are valuable. The subject is of the utmost importance. If it is a mere question of safety, there is no need of its being discussed, for the very reason that in a high speed engine we have got all we want in the four wheels and the eighteen-inch cylinder, and when we go beyond that our weight carries us to a ten-wheel engine. On that account I think that the advisability of the use of a ten-wheel engine should be discussed, and I would ask Mr. Forney if he would not put it in that way, and remove that limitation as to the safety.

MR. FORNEY—I have no objection at all to such a discussion, but I would very much prefer that it be confined in the beginning to the question at issue, because I feel very anxious to bring out clearly the object of my question. I accept the amendment that it be followed by the discussion on the relative merits of ten-wheel and mogul engines.

MR. SPRAGUE—I shall object to that, because it will follow into that any way. I would suggest that the gentleman hand in a question on that branch of the subject.

MR. LEEDS—The only object I had in asking that was this, that Mr. Forney proposes to discuss the safety of this truck, and then re-discuss the matter in connection with the advisability of its use, and therefore I ask that we take up the one question and sift it thoroughly, both as to safety and advisability of its use.

MR. FORNEY—I have accepted the amendment. I would put the question in this way: What are the relative merits of mogul and ten-wheel engines for passenger and freight service? The discussion to be opened tomorrow at the regular hour.

Mr. Forney's motion was carried.

PROPOSAL TO CHANGE THE TIME OF HOLDING THE ANNUAL CONVENTION.

MR. SETCHEL—I would like to say that members will all recognize the fact that there has been quite a good deal said in the mechanical press of the country about the great length of time it takes to attend this Convention. A number of superintendents of motive power that were at the Car Builders' Convention have gone home, which they would not have done if there was any arrangement made whereby they couid attend both Conventions. The Car Builders, have taken the initiative, and have appointed a committee to confer with a like committee to be appointed by this Association, for the purpose of arranging time and place of meeting. I want to offer a resolution instructing that committee in regard to the matter. It seems to me to be timely:

"*Resolved*, That the Committee of Conference to be appointed by the Association to act with a like committee from the Master Car Builders, be and are hereby instructed to vote, and if possible secure the passage of a resolution by the joint committee fixing the annual meeting of each Association at the same place each year, the Car Builders to meet the second Wednesday in June and the Master Mechanics on the first Monday after the second Wednesday in June in each year, and report an amendment accordingly for the action of this Association at the Twenty-fourth Annual Meeting."

Now, Mr. President, if I can meet with a second to this resolution, I would like to give my reasons for offering it.

The resolution was seconded.

MR. SETCHEL—The Master Car Builders now meet the second Tuesday in June. If they meet on the second Wednesday, they would have Wednesday, Thursday and Friday, and one day to take in any excursion or outside pleasure. Then the Master Mechanics could meet on Monday, Tuesday and Wednesday, and if they desired to end it there, both meetings could be disposed of in about seven days; or there can be another day taken after the Master Mechanics adjourn, for an excursion. It seems to me that that will confine the meetings of this Association in such a manner that there will be greater harmony; that railroad men will be more willing that the members of both Associations should go, and it will largely facilitate the business of both the Conventions.

The resolution was adopted.

THE PRESIDENT—I appoint the following gentlemen as that Committee: Mr. O. Stewart, Mr. Charles Graham, Mr. David Clark, Mr. G. W. Stevens and Mr. John Mackenzie.

MR. BLACKWELL—Is it intended that the meeting shall take place in the one place every year until some further amendment is made? Or is it intended

that the two meetings shall take place in one place one year and in another place the next year?

MR. SETCHEL—No, sir; it is not to meet at the one place annually, but at the same place.

THE PRESIDENT—If there is nothing further, gentlemen, I declare the business closed under this head.

APPLICATIONS FOR ASSOCIATE MEMBERSHIP.

SECRETARY SINCLAIR—I have applications for associate membership from four gentlemen: John R. Locksley, recommended by John Mackenzie and Albert Griggs; A. T. Woods, recommended by R. H. Briggs and John Mackenzie; W. D. Crosman, recommended by Peter H. Peck, George Gibbs and John Hickey; W. H. Marshall, recommended by John Hickey, J. N. Barr, Peter H. Peck and William Swanston.

THE PRESIDENT—I appoint the following committee to act on those applications for membership: Mr. Sprague, Mr. Blackwell and Mr. Meehan.

TO INVESTIGATE STANDARDS.

MR. HICKEY—I beg to offer a resolution at this time, if I am in order:

Resolved, That a committee be appointed whose duty it shall be to investigate the question of standards for the Association, to report on good or bad features of those proposed for adoption, and the maintenance or alteration of those previously adopted, together with the policy of attaching to the Annual Reports the drawings and specifications of the standards so adopted.

I offer that as a resolution, and I think it would be a desirable thing to appoint such a committee and let us see where we stand in relation to standards.

The resolution was seconded by Mr. Setchel and adopted.

THE PRESIDENT—We will appoint a committee after further consideration. If there is no more new business, we will close that order. The next business is Reports of Committees. The first report is on Exhaust Pipes, Nozzles and Steam Passages; best form and size in proportion to cylinders.

SECRETARY SINCLAIR—Mr. President, I have received no report on this subject, and I would call upon Mr. A. W. Gibbs, who is one of the Committee, to give whatever data he has on the subject.

MR. GIBBS—I would simply say that while part of the Committee has a report ready, we would be very much obliged if the thing could be postponed until tomorrow. The Chairman of the Committee is in Philadelphia today, and has written a letter that he will be here tomorrow.

On motion of Mr. Sprague the subject was postponed until the following day.

THE PRESIDENT—The next in order is the report of the Committee on Compound Locomotives; their efficiency as compared with small engines.

Mr. J. Davis Barnett read the report of this Committee, as follows:

COMPOUND LOCOMOTIVES.

GENTLEMEN—The slight experience America has had with the compound locomotive, although elsewhere there are between six and seven hundred in successful service, so contracts the possible field to be covered by a report on the subject assigned to us, that we, of necessity, must go beyond the limits of this land and of this association for the major part of our facts; and in expressing opinions and conclusions, are compelled to take for granted a fair acquaintance with its modern literature, giving the experimental results of trials carried on outside the American continent.

To commence with—and as a help in the direction of narrowing the province to be covered by this report—we would suggest for discussion the following questions, viz.; 1st. Is increase of boiler pressure an essential element in the success of compounding? 2d. What gains have followed compounding? 3d. What are said to be its losses? 4th. What, per engine, is the increased first cost of compounding? 5th. Does the saving more than balance the cost? 6th. What are American conditions for locomotive service, and can the compound locomotive meet them? 7th. Is it an essential defect of the compound that it must be short of starting power? 8th. Give a brief summary covering some details and peculiarities common to compounds.

1st. IS COMPOUNDING OF ANY VALUE WITHOUT INCREASE OF BOILER PRESSURE? This query is due to the repeated assertion that in compounding there was not, and could not be, an economy in steam consumption, except the boiler pressure be decidedly increased, raised to 170 lbs., or even higher. The results of the experiments of Mr. T. Urquhart, locomotive superintendent G. & T. Railway (Southeast Russia), contradict this statement. The trials cover a period of ten months, in the same class of service, with simple and compound engines practically of the same weight, and all with pressure of 135 lbs., and they show for the compounds a general average saving in fuel of 18 per cent.

Apart from this solution of the vexed question of pressure, Mr. Urquhart's experience is unusually interesting, because the experiments were carried out in cold weather, with oil fuel, which has a more uniform heating quality than soft coal; and the delivery of the fuel into the firebox was almost automatic, thus practically getting rid of the "personal factor," for which it is always necessary to allow in comparing special and brief experiments.

Mr. C. Sandiford, of the N. W. Railway, Lahore, India, reports a thirteen and one-half per cent. economy with unaltered, but still lower pressures, viz., 120 lbs., the saving being the same whether the steam was used in two or four-cylinder (tandem) engines.

These results will not surprise those who are familiar with exactly parallel cases in other forms of steam engineering.

Do not misunderstand us to say that there are no economies in higher pressures. There are wide possibilities with high temperature; and the many published figures, from recent trials, stoutly confirm our opinion. But under this leading heading, the committee wished to emphasize the fact that compounding, at ordinary working pressures, has its own value as an economizer of steam, without keeping hid the sister fact that higher pressures give an additional possibility. And it should not be forgotten that the very high pressure steam has, so far, only been fully utilized by passage through more than one cylinder.

Higher pressures and very early valve cut-offs, for simple engines, have had a fair trial on many of our railroads; nevertheless, today initial cylinder pressures above 150 lbs. are rare; and we believe that when boiler pressures higher than 160 lbs. are retained, it is with the object of making the boiler a reservoir of power for starting and grade climbing, rather than with a confirmed faith that very early cut-offs lower the fuel bill.

The Saxony Railroad report increasing their boiler pressures for simple engines from eight and one-half to twelve atmospheres (say from 120 to 175 lbs.), without resultant economy; whereas 212 lbs. has not proved too high for convenience or economy in the compound practice of the P. L. and M. Railway (France).

2. WHAT GAINS HAVE FOLLOWED COMPOUNDING? (*a*) It has achieved a saving in the fuel burnt averaging 18 per cent. at reasonable boiler pressures, with encouraging possibilities of further improvement in pressure and in fuel and water economy. (*b*) It has lessened the amount of water (dead weight) to be hauled, so that (*c*) the tender and its load are materially reduced in weight. (*d*) It has increased the possibilities of speed far beyond sixty miles per hour, without unduly straining the motion, frames, axles, or axle boxes of the engine. (*e*) It has increased the haulage power at full speed, or, in other words, has increased the continuous H. P. developed, per given weight of engine and boiler. (*f*) In some classes has increased the starting power. (*g*) It has materially lessened the slide valve friction per H. P. developed. (*h*) It has equalized or distributed the turning force on the crank pin, over a longer portion of its path, which of course tends to lengthen the repair life of the engine. (*i*) In the two-cylinder type it has decreased the oil consumption, and has even done so in the Woolfe four-cylinder engine. (*j*) Its smoother and steadier draught on the fire is favorable to the combustion of all kinds of soft coal; and the sparks thrown being smaller and less in number, it lessens the risk to property from destruction by fire. (*k*) These advantages and economies are gained without having to *improve* the man handling the engine, less being left to his discretion (or careless indifference) than in the simple engine. (*l*) Valve motion, of every locomotive type, can be used in its best working and most effective position. (*m*) A wider elasticity in locomotive design is permitted; as, if desired, side rods can be dispensed with, or articulated engines of 100 tons weight, with independent trucks, used for sharp curves on mountain service, as suggested by Mallet and Brunner. One such engine of eighty long tons is now under construction.

3. WHAT LOSSES ARE SAID TO HAVE FOLLOWED COMPOUNDING? (*a*) In some particular types, as actually proportioned, a loss in starting power of from fifteen to twenty per cent. However, loss of power in starting cannot be said to be a defect in the principal of compounding. (*b*) An increase in the number of parts. They are few and plain in the two-cylinder engine,

entailing little outlay in first cost or in repair. (*c*) A possible but, this committee thinks, not probable increase in the cost of repairs to the boiler, per pound of fuel burnt, if higher pressures are used. Positive information on this point is difficult to obtain. (*d*) An increased cost of repairs to the engine per mile run. This item is not yet large enough to be measurable, after three years' continuous service in the plainer forms of the two-cylinder compounds. (*e*) A larger percentage of failures on the road due to greater complication and size of parts. (*f*) Increased reciprocating weights on one side, either not balanced, and so increasing the deflection of the engine, or, if approximately balanced, the balance weight doing injury to the roadbed, etc. The two last sections seem to be pure suppositions, which, after search, we find no evidence to sustain. (*g*) Want of variability or adaptability to wide extremes in speed, and to amount of work to be performed ; so that a large compound does not work as cheaply when hauling light loads, or running without load, as a simple engine does.

It is not proved that a compound, working properly throttled, that is, with steam wire-drawn, may not have actually, as she theoretically has, a wide and economical adaptability. So that if the compound, like any other motor, be not as economical when exerting low power as when exerting full power, it probably will use less steam than the simple engine of same weight, working under similar conditions of light haulage duty.

However, the one thing certain about "American conditions" is that no large portion of our motive power does run lightly loaded, and until we have a wider experimental experience, it is not recommended that all locomotives, doing branch and local light service, be built compound.

4th. WHAT IS THE INCREASE FIRST COST PER ENGINE? M. V. Borries has published figures giving cost. In speaking of his own design of engine, he says they can "be built two to five per cent. cheaper than single engines of the same power—not of the same maximum tractive force ; because this power depends upon the boiler, which might be ten to fifteen per cent. smaller for the compound engine. If the same boiler is kept, as is commonly the case, the compound engine would be some two or three per cent.

heavier, and four or five per cent. more costly than a simple one; but, with properly dimensioned cylinders, ten to fifteen per cent. more powerful than the latter. For equal work the compound engine would always be the cheaper engine." Mr. E. Worthington says: "The intercepting valve and copper pipes forming the receiver, and the patterns for two different sizes of cylinders, are the chief items which raise the cost of a two-cylindered compound locomotive; while engines with three or more cylinders have additional parts, which considerably increase their cost. In engines with four cylinders, the tandem system is cheaper than the receiver system. Tandem cylinders are, however, objectionable, because the pistons are difficult to examine; but the receiver system is ready of access, and affords an opportunity of heating the intermediate steam by circulating it among the waste gases of the smoke-box; and, by isolating the high-pressure and low-pressure cylinders, an advantageous difference of temperature is maintained between them."

"The cost of constructing a number of two-cylindered locomotives does not greatly exceed that of the same number of ordinary engines. The cost of three-cylinder locomotives may exceed that of simple engines by $1,000 to $1,250 each."

The cost of changing simple to two-cylinder engines need not exceed $250 to $300 each, if the expense of drawings, patterns, and templets, be divided over a series of engines. The additional cost of building a two-cylinder engine, with receiver, etc., as used by the M. C. Railway, or the ingenious form of four-cylinder engine, as used by the B. & O. Railway need be little, if anything, over $200 (excluding royalties), or say from two to two and one-half per cent. increase on the cost of a simple engine.

5th. Does the saving more than balance the increased first cost? If, for convenience, the fuel saving be taken at seventeen per cent., or one-sixth, and the gross consumption at 900 tons per year, with coal at $1.50 per ton, the decrease in the annual fuel bill is but $225. Certainly not a wide margin to cover contingencies. If, however, at first only the most powerful engines are compounded, whose consumption averages 1,200 tons per year, and coal, as is common, costs on tender $3.00 per

ton, the saving on fuel is $600, or two cents per mile on a mileage of 30,000 per annum. As this amount would cover not only reasonable interest on first cost, but also allow for about thirty-three per cent. increase in total expenditure for motive power, repairs and renewals, the saving is certainly enough to permit a possible, but, we think, not a probable, largely increased cost of engine repairs, and yet have a margin of saving on the final balance sheet to the credit of the compound.

6th. WHAT ARE "AMERICAN CONDITIONS" FOR LOCOMOTIVE SERVICE? CAN THE COMPOUND ENGINE MEET THEM? We have given this section a large amount of attention, because it has so often been said that the compound must, to be successful on this continent, be adapted to suit American conditions, and your committee naturally were desirous of fully understanding these conditions. They have not been specified by those making the assertion; and we must reluctantly confess to having failed to identify, much less define them, so that after a long, unsatisfactory chase, they appear to us to be somewhat mythical. If any member can, and will, specify them, he will confer a favor, at least upon the committee, if not upon the association.

If an American condition be large starting power, then the Malett two-cylinder and all four-cylinder engines easily have cylinder power in excess of their adhesive weight. If American conditions be ability to do satisfactory work on a second-rate or third-rate roadbed, or simplicity of construction, or easy accessibility of parts, then these conditions are met by any two-cylinder engine, or by the B. & O. Railway four-cylinder engine.

Apparently neither climate nor men are factors in this equation, as compounds are a success in the hands of ordinary enginemen in partially civilized countries; and in hot climates, as well as in Russia, under conditions of low temperature and snow as trying as those ordinarily met with inside of fifty-one degrees, the present northern limit of our railway belt.

7th. IS IT AN ESSENTIAL DEFECT OF COMPOUND LOCOMOTIVES THAT THEY MUST BE SHORT OF STARTING POWER? Certainly not! The starting power of the Malett type is at least equal to that of a simple engine of the same weight, and its cylinder power can easily be made to exceed it, by allowing more than half boiler

pressure in the large cylinder for the first few revolutions. In the V. Borries, Wordsell, Pitkin and other two-cylinder types, and the Lepage three-cylinder engine, their starting power (as Prof. Woods has graphically illustrated), at 170 pounds, may be greater than that of a simple engine at 150 pounds, having cylinders of the same size as the high pressure, *during the first half revolution*, but after this the power (at low speed) of the compound diminishes to eighty or eighty-five per cent. of that of the simple engine. This conclusion is modified and improved by the knowledge that all two-cylinder engines originally designed as compounds have, or should have, their small cylinder larger than the cylinder of the simple engine of corresponding weight or duty.

It is possible, with the Lindner or equivalent form of starting valve—and a painstaking engineman—to get about ninety per cent. of the starting power of a corresponding simple engine. The Webb type of three-cylinder engine (except with the low-pressure crank dead on center) has cylinder power enough to slip both pairs of wheels, and no higher starting power is desirable. What may be called the opposite form of three-cylinder engine (the Sauvage type), with cylinders of approximately the same diameter, as used on the Northern Railway of France, has ample starting power, because the full boiler pressure is admitted direct to the two low-pressure cylinders. In fact, if desired, the locomotive can be continuously so worked, viz., as a simple engine. Tandem and other forms of four-cylinder engines are not wanting in starting power. The B. & O. Railway engine in starting with a gear as simple as the water-tap gear, puts the small piston practically into equilibrium, and thus admits high-pressure steam to the large cylinder.

A mean effective pressure of ninety pounds, in a simple 18x24 inch engine, will start a train of thirteen coaches on a level in a lively fashion, and a compound can easily give the equivalent of that total pressure, without being over-cylindered.

Going back to the two-cylinder style of engine, with automatic intercepting valve, and limited size of cylinder, it would seem as if all of them were capable of getting into motion the load they were designed to haul at full speed, so that their limi-

tations are that they do not get away quite as smartly, quite as noisily, or with the same tearing effort on fire and fire-box, as do certain simple engines that waste both fuel and steam in starting. The comparative difference, in time or distance, required by this class of compound to attain maximum speed, has not yet been shown by experiment, but is probably less than is generally supposed.

Mr. Urquhart, desiring to settle the question of the tractive power of simple engines altered to compound, with one cylinder unchanged, and with the boiler pressure unchanged, carried out tests, using both indicator and dynamometer; and he reports that at a speed of ten miles per hour the compound passenger engine suffered the following diminution, viz., in first notch, forty-two per cent.; in second notch, twenty-eight per cent.; in third notch, seventeen per cent.; in fourth notch, seven per cent.; and in fifth notch, or full gear, five per cent. And a similar test of the freight compound showed, in the first notch, twenty-seven per cent. loss; in the second notch, seventeen per cent.; in the third notch, ten per cent.; and in the fourth notch, or full gear, five per cent. He goes on to say that, for all practical purposes, in full gear a five per cent. difference, at this speed, may be neglected.

8TH: GENERAL:—A recent press notice credits Mr. Webb with an attempt to reduce first cost, by throwing away the valve gear for the low-pressure cylinder, and using in its place a single loose reversing eccentric—in other words, with an attempt to use an invariable cut-off for the large cylinder. And such practice is not unreasonable, if it from the first be acknowledged that the compound is designed for doing a maximum specific duty with high economy, and, therefore, the valve gear cannot be, and is not, arranged for a wide variability of service.

This intention in design most clearly marks all those engines using but one valve, or one valve stem, to distribute the steam to both high and low pressure cylinders; such, for instance, as the Vauclain piston valve, the Woolf hollow D valve, and the Dunbar single valve stem. In the two first mentioned most ingenious valves, the release of the high-pressure cylinder must be at the same moment as the admission to the low-pressure, or

it is no actual release; and the cut off in the low-pressure cylinder marks the exact point when compression in the high-pressure cylinder commences, there being no appreciable "receiver" capacity in the valves themselves, large as the passages through them have to be. There is, then, it is clear, little elasticity of adjustment in such valves and gears. The cut-off being early in the small cylinder, it must be early in the large, and as a result the compression in the small cylinder is enormous. Thus the conclusion is again brought home to us that the control of the compound, when small horse power is to be developed, must be chiefly through the throttle wire-drawing the steam, and thus reducing the initial pressure.

Putting emphasis on this truth will not frighten those who are familiar with the fact that wire-drawing is common today with our best enginemen. And it may here be noted that the *imperative necessity* for this so-called "crude practice" is the full explanation for the slight use in modern locomotives of screw and other finely divided reversing gears. This statement opens up the whole matter of cylinder condensation, but it is too large a matter to be properly treated in this report.

However, such modern experimenters as Westinghouse, Kennedy, etc., prove that wire-drawing the admission into cylinders of large surface and small volume is more economical than valve cut-offs at less than fifty per cent. of the stroke.

There are some constructive details and peculiarities about compounds that may deserve special mention. For instance, it is judicious to put safety or relief valves on the low-pressure chest or cylinder, but they should be so located or guarded that in case they came into action, they should not smother the engineman with steam, and obscure his vision. All types do not require water-taps on both cylinders, but most receivers should be so drained. If an intercepting valve is used a reducing valve is not required, and if an intercepting valve is not used, there must be a valve to give independent exhaust direct to the atmosphere from the high-pressure cylinder. The weight of evidence, so far, is in favor of the use of an intermediate receiver. Such a device effectually isolates the cylinders, so that each retains its distinctive temperature. The general practice of

drying the intermediate steam by putting the receiver in the smoke-box has much to recommend it. Copper pipes, set close to the curve of the smoke-box, are not cumbersome, or much in the way; and if it be desired that the feed-water also be heated in the smoke-box, the large receiver pipes need not interfere with the details of such an arrangement. Receiver capacity cannot, under our limiting conditions, be too large. It should never be less than one and one-half times the volume of the high-pressure cylinder, and two or more volumes are desirable; because, with a liberal receiver, the steam supply to the low-pressure cylinder is more uniforn in pressure and amount, the reheating or drying of the steam is more thoroughly done, and "the drop" in pressure between high-pressure final and low-pressure initial is less detrimental to steam economy.

If one side of a compound should break down, the other side can be run as a single cylinder engine, if the failure is not due to a total collapse of the cylinder on the side to be blocked. And in a tandem, as in a simple engine, the failure on one side may be a total collapse, without its interfering with the use of the other side as a single engine.

J. DAVIS BARNETT,
JOHN PLAYER,
H. D. GARRETT,
F. W. DEAN.

APPENDIX.

Size of cylinders for compound. M. V. Borries' rule for the large cylinder is:

$$d^2 = \frac{2\,Z\,D}{p\,h}$$

in which

d=diameter of the low pressure cylinder, in inches.

D=diameter of the driving wheel, in inches.

p=mean effective steam pressure per square inch (after deducting internal machine friction).

h=stroke of piston, in inches.

Z=tractive force required, usually 0·14 to 0·16 of the adhesion (say 0·15, it being understood that allowance is made for the external engine friction, taken as equal to the whole friction of the cars).

The value of p depends upon the relative volumes of the two cylinders (or, if their strokes are equal, upon their comparative cross sections), and from experience and indicator experiments may be taken as follows:

Class of Engine.	Relative Section, or Ratio of Cylinders.	p in Per Cent. of Boiler Pressure.	p for a Boiler Pressure of 176 lbs.
		Per Cent.	Lbs.
Large tender engine........	1:2 or 1:2·05	42	74
Tank engines...............	1:2·15 or 1:2·2	40	71

For engines working long grades Z should = 0·16. And if the steam pressure is increased from 15 to 30 lbs., and the cut-off is to be 0·3 to 0·4 of the stroke in the small cylinder, the large cylinder may be 1·5 that of the cylinders of the ordinary simple locomotive for the same service. These figures are from M. V. Borries' publication in 1888, and, as Prof. Woods points out, are an increase in cylinder volume of about 7 per cent. on those given in 1886; whereas Mr. E. Worthington, in 1889, quotes M. V. Borries as recommending that the small cylinder be made the same size as one of the simple engine cylinders, and that the large cylinders should be twice the capacity of the small; boiler pressure being increased as before.

MR. E. WORTHINGTON'S RULE.

The following illustrates a plain method of calculating the size of cylinders in a compound to possess the same maximum power, at slow speed, as a simple engine:

Simple engine.—Boiler pressure 150 lbs.; two cylinders 17×24 in.; wheels, 72 in. diameter. The effective cylinder pressure will be c × boiler pressure; then—

$$\text{Tractive power} = \frac{17^2\times 24}{72}\times c\times 150 = 14{,}450\times c$$

Compound engine.—Boiler pressure 180 lbs. Intermediate pressure 70 lbs., (difference 110 lbs.), stroke of cylinder as in simple engine, 24 in. Wheel 72 in. Let x represent the diameter of high pressure cylinder, then—Tractive power$= \frac{1}{2}\frac{x^2\times 24}{72}\times c\times 110\frac{1}{2}\frac{2x^2\times 24}{72}\times c\times 70 = x^2\times 42c$; that is $14{,}450c = x^2\times 42c$.

$x^2 = \frac{14{,}450}{42} = 344$; therefore $x = 18\frac{1}{2}$ inches, or desired diameter of high pressure cylinder; and $\sqrt{2\times 18{\cdot}5^2} = 26.1$ inches, or diameter of low-pressure cylinder.

He goes on to say that perhaps this method of estimating the diameters of compound cylinders may give slightly too large a result; for the average effective pressure in both may approximate nearer to the maximum effective pressure therein than in the simple engine, without running the risk of drawing fire through the tubes by a too violent blast.

M. Ch. Baudry, of the P. L. & M. Railway (Chemins de Fer de Paris à Lyons et à la Mediterranee) has given much attention to the compound, both as an investigator and expirimenter; and his "note" on this subject is very interesting. A translation of his formulæ for relative cylinder diameters. and their cut-off ratios for varying speeds and pressures, will be found in the *Railroad Gazette*, March 7, 1890, pp. 161-2, or *National Car & Locomotive Builder*, May, 1890, pp. 75.

J. D. B.

MR. SETCHEL—I move that the report be received. The motion was seconded and carried.

SECRETARY SINCLAIR—As it is close upon the hour for closing, and as this is a very important subject, I would suggest that this discussion be left over until the first order of business tomorrow. I should also think it to be desirable that the members take the copies of the paper with them, and study it out so that they may be able to discuss it intelligently in the morning. There is no subject that is more conspicuously before the motive power departments of this country at present, than compound locomotives; and I think it ought to be thoroughly discussed by the members of this Association.

On motion the meeting adjourned for the day.

SECOND DAY.

The Convention was called to order at 9 A. M.

THE PRESIDENT—The first order of business this morning, is the discussion of compound locomotives.

DISCUSSION OF REPORT ON COMPOUND LOCOMOTIVES.

SECRETARY SINCLAIR—Before the discussion on this subject comes up, I wish to say we have a gentleman present in the meeting who has given the subject of compound locomotives very great study, and is probably as well versed on that subject as any man in the country. He is not a member; he is an eminent mechanical engineer and a candidate for associate membership; but at present he is not eligible to speak upon the floor, without the permission of the Association; and I would move that the Convention give permission to Professor Woods to speak on this subject, if he wishes to.

Motion was seconded and carried.

THE PRESIDENT—Mr. Barnett being chairman of the committee is first entitled to the floor.

MR. J. DAVIS BARNETT—I am *not* authorized by the committee on compounds to apologize to you; but I think some explanation is necessary. It is almost unwritten law with us that a circular should be issued on every subject. That law was broken by your committee this year, for the reason, that so few of our members are actually running compound engines, and every one of you who has ever acted on a committee know the extreme difficulty of trying to make a consistent report, when in reply to circulars issued, the members send in a very large number of conflicting opinions that are based neither on practice or personal experience. We made it our business to find out what number of compound locomotives were running on this Continent, and after discussing the matter, it was thought best, in the judgment of the committee, not to issue a circular.

In preparing our report, we have endeavored to be as simple and as straight in our statements as we possibly could be. It would have been possible to introduce a very large number of tables of figures which I thought, and most of the members of the committee thought, would not add to the interest of the document as read on the floor of the house, however much more interesting it might have been as a document to refer to at any time. We wished to make as concise a statement as possible, and as interesting a one as possi-

ble, in the hope of evoking a reasonably, hearty and energetic discussion of the subject—and if it is your wish—I would suggest that the Convention discuss the report in sections, in the same way that the committee have divided it.

Take the first section: "Is compounding of any value without increase of boiling pressure?" A great deal has been said on the other side of the water, as well as in some of our own mechanical papers, to the effect that most of the success of the compound is due to the increase of boiler pressure, usually accompanying experiments with the compound. Therefore, the committee endeavored to get together all known cases where compounding had been done without increasing the old pressure. Tables are not given in this case, but the mean average results are given, and these results will not surprise those who are familar with experiments in this direction, in other classes of steam engineering. It is well known that compounding in steam-pump practice, mill-engines and marine engineering has been a success, even down to as low a boiler pressure as eighty pounds to the square inch. Two members of your committee promised to take this particular matter up, and bring some more definite facts before us today, to illustrate how in other forms of steam practice than that of locomotives, compounding at low pressures has been very efficient. These two members are not present with us today, I am sorry to say, and therefore, the figures which were to supplant these statements cannot be given.

I remember an expression used by one of the committee in talking this matter over. He said "compounding has been a success in every other direction than on wheels: why should it not be a success on wheels?" If it is to be a failure in locomotive practice, the conditions in locomotive practice must be radically different from other lines of steam engineering. If the conditions are radically different, I hope these members who take that view of the case will state their opinion very clearly this morning. Of course, any engine in which the horse-power is fairly continuous, day in and day out, will prove more economical as a compound than one in which the service is irregular. But in no case, even in the worst case I ever knew of, is it a fact that the locomotive only works half its trip, as once stated by a President of one of the English Engineering Societies. He said "compounding will never be a success in the locomotive; she runs up hill half the distance, and runs down hill the other half without using steam." I thought that was one of the most extravagant statements that had been made on this subject. The committee endeavored to make itself familiar with all the adverse criticism on this point, and I think this was the most extravagant statement that I met with.

In talking over this matter with Mr. E. W. M. Hughes yesterday, I learned from him that the figures quoted by the committee from the practice of Mr. Sandiford on the N. & W. Railway of India, refer to the same locomotives and experiments that he quoted in his communication to the Western Railway Club some months ago.

There are quite a number of experiments being carried on today, to find out what is the true value of an increase of pressure. An item has been cir-

culating through the technical press referring to experiments being carried out by Mr. Dugald Drummond in Scotland, in which the pressures vary, (if I remember aright), between 160, 180 and 200 pounds. But, if I am not misinformed, Mr. Drummond is using engines of exactly the same size, not only of boiler but of wheel and cylinder, and it seems to me that any information that he may get from those experiments will be unsatisfactory. High pressure and very early cut-offs in the large cylinder will give disappointing results. There is a friend of mine who is taking, it seems to me, a far better course in this matter. He has a compound engine running at about 170, and has two simple engines with wide variation of pressure; but they are of the same weight, and their tractive force at normal cut-off is about equal; that is, where he is using the very high pressure (close on to 200 pounds) he is using also a small cylinder, so that this engine is working as nearly as possible under similar conditions to the other two engines. He is testing these engines for three months, with a skilled third man on the foot-plate to take all the figures; and I anticipate that when he communicates the results to the public we shall get some very interesting information, for it seems to me that he is experimenting correctly and in the right direction.

MR. P. H. PECK—Mr. Meehan, Superintendent of the motive power of the Queen and Crescent System, had a letter to bring up this morning, but he could not be here today, as he was called to Philadelphia; and he requests me to hand it to the Secretary.

THE PRESIDENT—Will Professor Woods please step up to the desk and speak to us while the Secretary goes over this letter.

PROF. WOODS—I suppose it is entirely unnecessary for me to say here that I am in favor of compound locomotives. I have been saying it pretty constantly in one of the papers for the last few months. It would be rather unnecessary to repeat it; but I would say that several years ago when I started the study of compound locomotives, it was with very great doubts about there being any field for compound engines for locomotive work. In the first place, there are, of course, a great many difficulties; and it seemed to me that the difficulties were going to be too hard to overcome. But as I got into the subject deeper and studied it more, I began to see a way through the difficulties, and our friends on the other side of the water have been going ahead and making experiments; all of which carry out just what we would expect as the result of compounding. They have overcome the difficulties, and as far as I have been able to hear, they have invariably made a gain by adopting the compound system. I have been unable to find a record of but one compound engine which was a failure. That was in this country on the Boston & Albany. I have not been able to get any facts in regard to that; and I think it would be very well if some of the members present could give the Association some figures in regard to that which would furnish a ground for some explanation of it.

A good many of the arguments that are being brought forward by, we may say, the opponents of the compound system as applied to locomotives, are

almost exactly the same as had been used in years past in marine work. They are going over just exactly the same ground as was gone over fifteen years or so ago in regard to the marine engines. Now we all know what they are doing in marine engines today—that in the large engines, and even down to torpedo boats, they are using treble and quadruple expansion engines, and they are not using compound engines except in steam launches and small craft of that sort. The increase in the number of cylinders has been almost invariably accompained by an increase in boiler pressure. But, as has been stated here this morning, that does not seem to be a necessary accompaniment when applied to locomotives carrying a pressure of 125 or 135 pounds. Mr. Urquhart's experiments in Russia seem to establish that pretty clearly.

In regard to the various systems of compound work, which have been presented and which are in use, we frequently hear it stated that this engine does work well or doesn't work well, and the mechanical features of the engine are brought into the problem as a factor, in the compounding. Now, I think that is entirely a separate question. If you have a compound engine, and you get greater expansion from the steam with such a point of cut-off in the cylinders, that you have a better distribution and you reduce your condensation, you must get economical results. Now what system is used to get that, is another matter entirely. It would be very largely a question of individual preference whether you are going to use, two, three or four cylinders. Of course, you would naturally want to take the simplest form, and as the report has shown, there is no difficulty in the starting power, which is another question which has been brought up against the compound. We must admit that the compound locomotive is not as flexible as the simple engine. You cannot have as wide a range of work and have it work satisfactorily—that is to give you an economy. It will work—there is no question about that, but if you are to get economical results, the engine should be designed for the work which it is to do. There does not seem to be any great difficulty in that nowadays; that is to say, if you want a freight engine for slow speeds and heavy work, there is no reason why you cannot get an economical engine for that purpose. The same holds true if you want an engine for fast passenger service. But it is not to be expected that you can put a compound that is designed for passenger service, and expect it to work at about one point of cut-off, that is not a very wide range, on another class of work entirely and get as good results. I do not mean to say that you cannot work a compound anywhere. You can work it wherever you can work a simple engine, but it ought to be designed for the particular class of work for which the engine is intended.

I do not wish to be understood as setting up as an authority on this subject. It is something that is new to us all, and it is something I have happened to put considerable time on. If there are any questions gentlemen would like to ask, I would be pleased to answer them if I can do so. (Applause.)

MR. BARNES—I would like to ask Mr. Woods to explain what he means by the lack of range in the compound locomotive as compared with the simple engine—whether it is difference in the range of economy or range of work, and if in the range of economy, where that difference lies?

PROF. WOODS—I meant in regard to that simple question of economy. As I said, I see no reason why a compound engine will not work anywhere that a simple engine will. But the only object in using compound engines is for economy. Now in any class of work, if you are working for economy, you have got to understand what the work is to be, and design your engine on that basis.

THE PRESIDENT—I was about to call on Mr. Pitkin to tell us something with reference to the defects in the Boston & Albany compound. I understood that he knew something about it.

MR. A. J. PITKIN—The Boston & Albany compound, as I understand from the blue prints I have seen of the engine, was a tandem engine having a small cylinder forward of the large one; that is the large cylinder occupying the same position as on an ordinary locomotive, and a small cylinder being bolted directly forward. I understand that the engine did not meet the expectations of the designer, and in looking over the blue prints, I am inclined to think that the trouble was not in the principle of compounding, but rather in a defect of designing. The openings passing through one cylinder to the other were, if I remember right, only about two and one-half inches in diameter. Any one can readily understand that the steam would be greatly wire-drawn and great condensation would take place, especially as the steam had to pass in those small passages the entire length of the small cylinder. I believe thoroughly in the two-cylinder type as the proper form for compounding; and that there would have been great economy in that engine, had she been properly designed. I think there is no question that, with any form of compound if properly designed, there will be considerable economy.

THE PRESIDENT—Mr. Hazlehurst, I understand has one of these compound engines running; and I would like to hear from him.

MR. HAZLEHURST—The engine at present is in the hands of the Baldwin Locomotive Works, and all information on the subject is entirely in their possession. They claim to have made some saving in fuel, but the engine has not been running a sufficient length of time to determine the absolute saving. Such diagrams and such tests as were made, were entirely in their interest.

The President called upon Secretary Sinclair to read a letter which had been written to the General Manager of the Louisville & Nashville Railroad by Mr. Pulaski Leeds, in answer to enquiries made as to the desirability of the Company purchasing compound locomotives.

Secretary Sinclair read the letter as follows:

LOUISVILLE, KY., June 13th, 1890.

J. G. METCALF, ESQ., *General Manager*.

DEAR SIR:—In answer to yours of the 2nd, inst., asking if I would recommend the purchase of compound engines, I would respectfully reply: I would not at present recommend such purchase, my reasons being that the compound locomotive has not yet been perfected to its possibilities: nor do I believe it will ever do all that is claimed for it, at the same time there are

enough railroad companies ready to build and try these engines, which will develop the defects, as well as demonstrate their value. This will give later entries in the field, points from which to design more intelligently. While the compound principle has proven a full success as applied to condensing engines, we are trying to obtain the same results under altogether different conditions; first, in the condensing engine they are enabled, by using different areas, to expand a high pressure steam down to a point where it is practicable to condense it economically, that is without overloading the air pump, thereby getting the full benefit of expansion, besides getting a large area of piston for the vacuum to work on. In this way they get the benefit of high pressure expanded to the utmost, and the same result from vacuum as they would on a single cylinder of the same diameter as their largest, and stroke enough to contain the value of both, or three if triple, besides less loss from radiation and consequent condensation of their live steam.

A radical difference in conditions is, that we have to maintain a back pressure of about sixteen pounds, for the purpose of exhaust to fan our fires; but the principal thing to be decided is the proportions or ratio of cylinders. You will have noticed the different writers vary in their recommendations, from the same size of cylinder for high pressure, to one inch larger than a simple engine for same power, but in the low pressure they vary from two and one-tenth to three. This comes from the fact that each of these various proportions suits certain conditions, and a compound engine proportioned for certain work is most economical, when doing just that work and its economy decreases as you vary from that point. This arises from the fact, that as the mean volume effective pressure in high pressure increases, you need just that much more or area in low pressure, cylinder in which to expand steam and *vice versa*, thus: we will take a high pressure cylinder of the same diameter as simple engine, say twenty inches, although the diameter has no bearing on the principle. Now this cylinder will exert just the same power as the same cylinder in a simple engine, less the back pressure on its own area at the mean effective pressure in low pressure cylinder, which if steam was admitted full stroke, and the other cylinder was to do the same work, would be just one-third the boiler pressure. If we admitted one hundred and fifty on one side of small piston for the whole of the stroke, she would expand into three volumes, or fifty pounds on the low pressure cylinder, hence you would have a pressure of one hundred and fifty pounds on one side of your high pressure piston opposed by its own area at fifty pounds, but you would have fifty pounds pressure on twice the area of this piston doing its work in the large cylinder. Thus, the power of your compound at one hundred and fifty pounds pressure, admitting steam full stroke, would be the area of the small piston, multiplied by mean effective pressure of one hundred pounds, added to the area of large or low pressure piston multiplied by mean pressure or fifty pounds. Thus the power of a compound would be, area 314.16 x pressure 100 x stroke 24 and area 628.32 x 50 x stroke 24 = 14,079.68 pounds of power. A simple engine of the same diameter, twenty inch would give area 314.16 x pressure 150 x stroke 24 = 11,309.76 pounds of

power with the same volume of steam, no allowance being made for terminal back pressure, all this being one stroke only, and an impossibility in practice, being introduced only to demonstrate the difference in results to be obtained under certain conditions. As you will note, the power given above is for a complete compound engine with two cylinders, while the other is only one-half, of a simple engine, but which has used the same amount of steam, and demonstrates that, disregarding the economy, and using all the steam needed to make two strokes of the piston in the simple engine, the same as has been done in the compound, you would have to use a larger cylinder to obtain the same power in the compound, as the two strokes of simple piston would give 2,261,952 pounds, but would use twice the volume of steam.

Now for the different conditions, as you will notice in all experiments, they use an excess of pressure over the simple engine: in this they have the advantage. First, from the fact that it has been demonstrated that it is not any saving whatever to compound at low pressures, the mean average being so low as to lose the benefits, and the exhaust cannot be kept up to proper degree with properly proportioned cylinders. On the other hand, the use of this enormous pressure, when cut off to a degree to get the full benefit of expansion, causes the cylinder to cool to that degree, that there is a loss when you admit fresh steam, but giving them every advantage we have the following results under different conditions. An engine compounded in the proportion of two to one, and carrying one hundred and seventy pounds of steam, would have a maximum mean pressure of ninety-three and three-tenths pounds on high pressure cylinder, and forty-six on low pressure cylinder when cut off at three-quarter stroke, while a simple engine at same cut-off, but carrying only one hundred and fifty pounds, has a maximum mean pressure of one hundred and twenty-two pounds. This would give, using the same sized cylinders as before, twenty inches for high and twenty-eight and about five-sixteenths for low pressure cylinder the following comparison: Area 314.16 x pressure 93 x stroke 24, area 628.32 x pressure 46 x stroke 24 = 1,394,865. The simple engine with the same admission, or if you will pardon the term, one mouthful of steam at one hundred and fifty pounds, would give area 314.16 x pressure 122 x stroke 24 = 919,860,48, but if she completed her revolution and made two strokes, which the compound has to do, then she would develop 1,839,720.96, which would call for a compound to be, high pressure cylinder twenty-two and three-quarters with a low pressure cylinder, thirty-two and one-quarter inches diameter, to do the same work as a simple engine of twenty inches diameter same stroke, but using one hundred and seventy pounds on compound as against one-fifty on simple. Not to make too many comparisons, we find the proportions coming closer together as we cut-off shorter until we get to one-third stroke, where the same sized cylinder for high pressure of compound, as for simple engine does just the same work, holding the difference in steam pressures. Of course by moving platforms and stations these proportions could be applied, or we can use four cylinders, but right here comes in the question of true economy, varying as the comparative cost of fuel and repairs vary. If the

cost of repairs is increased by the extra sizes, especially weights of reciprocating parts, which have in turn to be counterbalanced, then the economy is reduced in just that degree, and, as repairs do not vary in cost per mile in the same degree as coal does in different parts of the country, what might be a great economy at one point, would only just balance in another.

You will notice that in all reports, so far made, there is nothing definite given. The Webb Engine, imported from England, has developed about the same power, after starting, as one of our seventeen inch engines of the seventy type, but you would not tolerate her one trip on account of not starting with more than about four cars. The Michigan Central report says their engine did good work with some degree of economy with freight, but when put on passenger service, they had to cut out her valves thus lessening her power for the sake of speed. Another thing, this report only covers five cars, on a level road at fifty miles per hour. My deductions after years of observation and study on this point are, that there is a combination of points in compounding, (of which the higher pressure is not the least,) making it possible to do the same work with about fifteen per cent. less fuel, and that at least one half of this is lost in repairs where fuel and repairs to mile run are nearly equal. When such men, as compose the Western Railway Club, while acknowledging their belief in compounding, declare that they do not know why there should be or is any such economy. then there is nothing for it but to experiment and observe the results of different proportions and design.

Mr. Angus Sinclair, Editor of the *National Car & Locomotive Builder*, is a man with whom I discuss all such matters more than any other. Before he went to Europe he was a strong advocate of compounding ; after his return, I quote, " It is an open question, there being the most violent conflict of opinion on the subject among Locomotive Superintendents in Europe, where they ought to know all the comparative values. A month spent in the home of the compound locomotive took away a great deal of the faith previously held in that type of engine."

I have not heard of any of these gentlemen who have ordered compounds advancing any novelties in their construction, and the only thing they gain in owning them is, that they can observe at home, while the rest of us can get the data of from others, their actual gain or our loss being but a very small amount in dollars and cents, which we can well afford to lose for one year, if at the end of that time the engine is better porportioned for adoption.

Yours truly,

P. LEEDS, S. M.

Mr. Swanston wanted to hear what Mr. Angus Sinclair had to say for himself about compound locomotives.

SECRETARY SINCLAIR—I have devoted a great deal of thought and study to the compound locomotive, and every day brings to me new evidence that impresses me with the small extent of real knowledge I have about this type of engine. I was three years working among compound marine engines and

was very familiar with that type of engine. I know that those engines are much more economical than any form of simple engines in use. I used to believe, that a simple marine engine could be made to work just as economically as a compound, if it had such a valve motion as the Corliss gear, and had the steam admitted quickly and expanded down nearly to atmospheric pressure in one cylinder. I was induced to believe that there must be a good deal of unnecessary friction in the multiplication of cylinders in a compound engine with resulting loss of power and loss of steam. It came about that I had the opportunity of seeing the working of a marine engine with practically a Corliss gear, and I was forced to the conclusion that it could not come up to the commonest form of vertical inverted compound engines in economy; and that it was harder on repairs than the compounds. If you get a great pressure of steam put suddenly into the cylinder at the beginning of the stroke it puts an enormous blow upon the piston connections and it makes the machinery hard to maintain. It seems to me that the same principle applies to a great extent to simple and compound locomotives. No one has been a greater believer in the simple locomotive than I have been. It seems to me that I have been going through something like the same kind of training on locomotives, that I went through on marine engines. It is perhaps not creditable to my judgment, that I did not see that the cases were nearly analagous ; but I, like Mr. Leeds, was impressed with the belief that the condensing of steam made a very great difference to the success of the marine compound, and consequently I was disposed to question the ultimate success of the locomotive compound principle for want of the condenser. As Mr. Leeds has mentioned, I was more favorably impressed with the compound locomotive from reading the accounts in European journals before I went and saw the engines at work, than I was when I returned. Mr. Pitkin and I were in Europe together. We visited a good many places where there were compound locomotives at work, and he acknowledged that the talk of the people there was like pouring cold water down upon his back, or something similar, and I had something of the same impression. But since I came back and had some experience with the working of the compound on the Michigan Central my views have changed. I went out to watch the working of that engine considerably prejudiced against it. But I was compelled to believe and acknowledge, that there was a great deal more in the compound principle for locomotives than I had been previously willing to admit, and that the engine was mechanically and economically a success. Yet it is not pleasant for me to make confession of my mistakes. I evidently have made a good many mistakes in regard to the compound locomotive, but I would rather acknowledge a mistake than hold on blindly to a prejudice after I had found out that it was a prejudice founded on error. (Applause.)

MR. H. J. SMALL—On the Pacific Coast we are very much interested in compound engines, that is, in knowing what the probabilities are of the results to be obtained from them. Our fuel expense per mile is probably greater than most of the roads have for the total engine expense. A very

small saving in fuel helps us very largely in that case. One of my chief objects of investigation in coming East was to find out what has been accomplished by the compound engine. Can it be used to advantage on a road that has mountain grades as high as 174 feet to the mile? Perhaps some of the members, who have direct experience with those engines as far as we have gone, can give us some information. If the builder will guarantee an engine to do as good work and more economically than the simple engine I would like to know that. I came East expecting to find a great deal of information about these things, but I find that facts are somewhat scarce.

MR. BARNETT—In endeavoring to open this discussion this morning, I was in hopes that we could discuss it by sections. That is why I sat down after giving the point which I considered relevant to that first section, namely, are there any benefits in compounding without increasing the pressure? The matter has traveled beyond that point, and we have come to a general discussion of the compound engines.

The first point mentioned was that of the Dunbar engine. If I am not misinformed the patentee of that compound was not present on the Atlantic coast at the time the detail drawings were worked out and the patterns made. All of us are pratical men, and we know the disadvantage there is in details of any scheme that we initiate being carried out in our absence. No one has the interest that the inventor or designer has himself. No one watches the details so closely, and no one is so thoroughly interested in seeing that all the work is done as it should be done. Therefore, if Mr. Dunbar was not present when that engine was made, it is not surprising that the engine was not the success that he anticipated. Every novel departure in steam engine construction of that kind, requires a great deal of thought, and requires a great deal of adjustment and experiment. All the inventors of compounds have varied from their first ideas, varied in minute points, and no doubt if Mr. Dunbar had had the opportunity he would have changed his engine to give it elements of success.

The same remarks will apply to the Baltimore & Ohio engine built by the Baldwin Locomotive Works. Their engine was an experimental engine—in the wide sense of the word an experimental engine; and I do not think I am telling secrets out of school, when I say they were disappointed with the proportions of their own valves and steam ports in their first engine, and today the Baltimore & Ohio engine is not running with the same piston valve and openings that she started with. When I rode on her down from Philadelphia to Baltimore and back, she was running with a small piston; the steam from the high pressure exhaust and the low pressure cylinder passed through the body of that piston valve, and the space there was not large enough to pass that volume of low pressure steam through in the time allowed, when she was running. They endeavored to get up high speeds. I think under favorable conditions we did get up to sixty miles an hour.

The experiments throughout the whole of that period, were carried out by the Baldwin people. They were extremely busy. The Grippe threw the

Baldwin Works back very much. Another difficulty was they were not able to make the changes on the engine that they anticipated. Therefore, it was a long while before they were able to get hold of the engine and try a larger valve on her. Hence the absence, as I understand it, of direct experiment by the Baltimore & Ohio people. The Baldwin people had not practically handed over their compound to the Baltimore & Ohio people until quite recently.

This section that I endeavored to open embodies certain facts which, I think, contradict Mr. Leeds statement that the success of the compound, so far, is due to higher boiler or initial pressure. Knowing how important that fact was, the committee collected all the information they could get on that point. Some of the persons making those statements are not, as I think, interested in making misleading statements. A more trustworthy engineer, I believe, does not exist on the face of this globe than Mr. Urquhart. I never had the pleasure of meeting the man. I know something of his history. I know the confidence the Russian Government put in him. He is the only man in the pay of the Czar who has not been called upon to swear fealty to the Czar. I only say that to illustrate the character of the man; and I think when Mr. Urquhart, having carried out experiments over a large period, makes over his own name positive statements showing economy in oil consumption under circumstances where the firemen could not do any jockeying with the fuel, that we should believe Mr. Urquhart. At any rate, until further evidence comes before me, I am going to pin my faith to Mr. Urquhart's experiments and trials.

If I understand Mr. Leeds aright, he infers that the loss by radiation and condensation is larger in amount in a compound engine than in a simple engine. Am I mistaken?

MR. LEEDS—You are, sir.

MR. BARNETT—Mr. Leeds also states that the increase in repairs of the compound locomotive is excessive. The original engines built by Worsdell do not sustain that statement. Worsdell has been using his own design of engine for three years, and some of those engines have not been in the shop for three years, and seeing that those locomotives are largely experimental engines, it seems to me that the cost of repairs and renewals on them cannot be excessive. I presume the mileage in those three years is not equal to the mileage made by the average American engine. There is no doubt that to keep an engine out in England for three years is good work, because they expect to take an engine into shop earlier than we do on this Continent. The English public do not as good-naturedly put up with the failure of an engine on a train as the average traveler on this Continent does. It is the practice in England, as we almost all of us who are familiar with English practice know, to take an engine into shop before she is worn down to the low point that we wear her down to in America. Therefore, Mr. Worsdell's figures are that the compound does not increase the expense of repairs. When I speak of the compound I mean the simple type of two-cylindered engine. No person is endeavoring to prove

the weakness of the compound so thoroughly as F. W. Webb. It is contrary to English practice to double-gang on a locomotive, whereas, Mr. Webb is running one engine continuously extra-ganged; running the engine in continuous work without dropping fire, so as to achieve a mileage, if my memory is not at fault, of one hundrerd thousand miles a year. That should develop any working defects.

I am quite willing to grant you an enormous amount of surface subject to work on the three-cylinder Webb compound engine. But I cannot imagine any treatment that would better develop any hidden defects, or any hidden weakness, or any tendency to self-destruction in compound engine than Mr. Webb's practice today, of running his engines continuously without shedding them at all.

The report mentions the fact, that if coal be at three dollars a ton and the number of tons used be 1,200 a year, it leaves a margin to cover locomotive repairs and renewals of two cents per mile. I do not know what your practice is all over this Continent, but six cents per mile with many railways will fully cover repairs and renewals of stock. Therefore, if in addition to that, you can achieve such an economy of fuel as to have eight cents per mile for repairs and renewals, I think the committee is justified in making that emphatic statement that you could afford to pay a little more for repairs and renewals on a compound engine if she wears away quicker than the simple engine, and yet have a margin left on the General Manager's balance sheet.

Mr. Pulaski Leeds—Where Mr. Barnett says that I make the assertion that repairs are excessive, you will please note, I say if the repairs run up the percentage to such an extent as to more than balance the gain through saving of coal; and you will notice, that I proposed to my General Manager merely, to await results until the thing has been developed as to whether it is economical to make the saving on fuel as against other expenses. He says I make the assertion that expenses for repairs are excessive, etc., which I think our mechanical experience will bear out—that under the same conditions any multiplicity of parts means excessive weight, and any excessive work in our reciprocating parts especially leads us up to that dread bugaboo—the hammer blow. I do not make the assertion that it has been demonstrated that the repairs are excessive. I merely make the suggestion that we wait and see whether they will be or not.

The President—I would like to know if there is any one here who knows anything with reference to the performance of the Michigan Central compound. Perhaps Mr. Pitkin can give us some data in reference to that engine.

Mr. Pitkin—The only thing I will state about that engine is in relation to some questions that have been brought up, with reference to the compound. As to the starting of trains, the experience borne out in this engine is, that it is quicker in starting trains than the plain engine. I attribute this rather to the cylinder power than to the principle of compounding. I see no reason why the compound cannot be fully as quick in starting a train as the simple engine. This engine has cylinders, I think, a little larger in proportion to the

weight than on plain engines. The plain engine of the same weight on drivers has cylinders 19 x 24. This engine has a high pressure cylinder of 20 and a low pressure of 29. In a new engine of this type, I have reduced the cylinders for the high pressure to 19 inches and the low pressure double that area.

Speaking of the power of the locomotive, I think it is the safe rule to take size of the large cylinder and figure on your boiler pressure, the distribution of power between the two cylinders being in accordance with that varying power.

Our experience has been that the compound engine handles the train better than the plain engine. This may be somewhat due to the little larger cylinder power. I can hardly see how the cost of maintaining additional parts will amount to very much of a figure, as the only additional part in the two-cylinder engine is the intercepting valve. That certainly cannot require as much repairs as an air pump would require. There have been no repairs whatever on the valve of this engine. The intercepting valve has not been out since the engine started into service about six months since. I suppose the best evidence of success is the financial arrangement. The engine was settled for within thirty days after it went on the road. We are building three compound engines, two consolidation and one ten wheel passenger, and we have in contemplation another compound having larger drivers. I think this is a point that it is well for us to bear in mind in contemplating the compound principle. There is no question but that the back pressure on the high pressure cylinder at high speeds is excessive. Of course, as in all new engines, this engine was more or less of an experiment, and we started in with very little clearance in the high pressure valve. That was increased up to three-eights and still the back pressure at the point of release was as much as the steam pressure, so that the piston was practically balanced at that point, showing that there was no loss by cutting out the valve. It has been running on a long trial on freight, showing no weakness and showing very great economy in fuel. I regret that it has not been running however against an engine of a similar type. I think they intend in a week or ten days to put it in service with an engine of the same type and make a fuel test. Of course, you know that a ten-wheel engine as compared with a mogul engine built six or eight years ago is not much of a comparison. But the engine on eight trips has shown an economy of sixty per cent. of fuel over the ordinary eight-wheel locomotive. I think from what Mr. Sinclair has reported on the test, that there is no question but what an economy of from twenty to twenty-five per cent. can be gained in freight service with the two-cylinder compound locomotive ; for passenger service, perhaps not quite as much owing to this back pressure. But I think it is safe to say from fifteen to twenty-two or twenty-three per cent. in passenger service.

I wish to state in regard to the criticism made on Mr. Sinclair about his going back on himself, I will admit that when I landed on this side of the

Atlantic, I thought if we could make a success of the compound we would be fortunate. But there is more room for the compound engine in this country than abroad. It seems to me that they handle trains abroad with about what we waste. I am sure we can show a far better result than they get abroad, owing to the excessive duties we get from our locomotives. Imagine a plain 17 x 24 locomotive burning eight tons of coal in three hours and a half. You can understand there is very little economy in that. Anything that will give us better distribution of steam is certainly a great advantage. I think one great saving of the compound over the plain engine, is the cylinder condensation, the temperature in the cylinders remaining more nearly the same In ordinary locomotives the temperature will probably vary about 150 degrees, whereas in the compound it will vary from 60 to 90 degrees in each cylinder, so you will not put your high temperature steam into a refrigerator.

So far as re-heating the steam in passing around the smoke box is concerned, it has got to go around in about one fifth of a second, in going a mile a minute, and you cannot imagine that it absorbs much heat. I think however that the steam can be delivered from the high pressure to the low pressure cylinder at about the same temperature.

MR. BARNES—I think Mr. Pitkin might give us some valuable information regarding the relative cut-offs in the high and low pressure cylinders.

MR. PITKIN—This is the only point that we had to contend with in this locomotive—Master mechanics have trained their engineers so well in cutting off at an early point in the stroke and running the engines with the reverse lever instead of the throttle lever. We have one of the very good engineers on the engine; he naturally thought, closely linked up was the proper way to run it. At any point of cut-off earlier than 8 inches, the back pressure is enormous; and I doubt very much if there is any economy in running at high speeds much short of 12 inches. In fact in the locomotives we are building now, we shall not put in any opportunity for the engineer to cut-off much earlier than ten inches—that is in both cylinders. We make no difference in the point of cut-off on either cylinder.

On motion, the discussion was closed.

REPORT OF COMMITTEE ON ASSOCIATE MEMBERS.

SECRETARY SINCLAIR—Before we proceed with the next order of business perhaps some committee is prepared to report.

MR. SPRAGUE—I am authorized by the Committee on Associate Members to say, that we recognize our entire inability to conscientiously report on this subject on so brief a notice. I, therefore, in lieu of a report of this Committee, submit a resolution for a change in our Constitution requiring a year's time to report on associate members. You are all aware that our list of associate members, according to the Constitution, is nearly filled; and that we ought to be careful to admit only just those who will be of special benefit to

us, and with the little time and information we have, we cannot conscientiously report on this case. I therefore ask leave to submit the following resolution for a change in the constitution next year.

PROPOSED AMENDMENTS TO CONSTITUTION.

Section 2nd., Art. 3 says "Civil and Mechanical engineers or other persons having such a knowledge of science or practical experience in matters pertaining to the construction of rolling stock as would be of special value to the Association, or railroad companies, may become associate members on being recommended by three active members."

Now I would insert this clause :

"The names of such candidates shall be reported to a committee appointed by the President, and whose report shall be made at the next annual Convention. If the report be unanimous in favor of the candidate, his name shall be submitted to ballot at any regular meeting and five dissenting votes shall reject."

That is practically what is in the clause now. It is only requiring a year's time before reporting.

The motion was seconded and carried.

MR. MACKENZIE—If I am in order I would like to offer a resolution under the same section.

MR. SWANSTON—I move that the committee have until the next annual meeting to report.

MR. SPRAGUE—It is optional with the President to continue the present committee or appoint a new one. If the committee has a year to report that will do.

MR. Swanston's motion was carried.

MR. MACKENZIE—I would like to add to Section 3, of Article 3, the words, "should calls be subsequently presented for re-instatement of such members the Executive Committee shall have power to decide the matter."

This is the case of men being dropped for non-payment of dues or other causes. The Executive Committee have no authority whatever now in handling these cases, and if the authority is extended to the Executive Committee in cases of members being dropped, they can exercise that authority by re-instatement if they think best. We have several members now who have been dropped on account of non-payment of dues, and who are out of practical service, and who are anxious to become members again, and there is no way of getting them into the Association. They are not eligible to new membership, and for that reason they are lost to us.

MR. HICKEY—I should like to give notice of a change in the Constitution, being paragraph 3 of Article 3. I believe it now says "two representatives from each locomotive building works." I would like to add to that "two representatives from each locomotive and car building works," so that car constructing works would also be represented in this Association.

NEW HONORARY MEMBERS.

Mr. R. W. Bushnell—I have been requeseted to suggest that the name of Mr. J. M. Foss, of the Vermont Central be placed on the list of honorary members.

Secretary Sinclair—I second the motion. Before putting the motion, I wish to say that Mr. J. M. Foss is one of our oldest members. He is now General Superintendent of the Central Vermont, and has been that for several years. He was a very valuable member in the early days ; took any active interest in the affairs of the Association, and all the older members will remember him perfectly well. He is in a position now where he cannot attend the meetings and take an active part in them, as it would take him so away from his road ; and it seems to me that it is only right that all members of that character and position should be made honorary members.

The motion was carried.

RE-INSTATING DROPPED MEMBERS.

Mr. Setchel—I just wanted to say a word about the question of dues. The same rules and by-laws have existed ever since the foundation of the Association pretty nearly, and it has been the practice heretofore, except in a few isolated cases, where members had gone out of business entirely and had became railroad men again, and they join as new members—a few such persons have been admitted by simply paying their dues. But in a number of cases where members have been behind as much as five years, they have come forward and paid all their back dues—a great many $20 at a time and $15 and $10, and this has been the rule always that members in arrears for dues shall pay their dues up before they are re-instated.

Mr. Mackenzie—The Executive Committee in talking that matter over and putting this addition to the rule, would have the members understand that if any of them are re-instated they will pay all their back dues.

Mr. Setchel—I did not understand that. There is nothing to prevent members from being re-instated if they pay their back dues.

Mr. Mackenzie—The Constitution prevents it.

Mr. Setchel—The names shall be dropped but it does not say they shall not be restored.

Mr. Mackenzie—How are you going to restore them.

Mr. Setchel—Simply by the payment of the dues. After two years they are dropped. Then, if they pay up they are restored.

The President—That would probably be applicable to a member who is still in the motive power department. But the question was brought up in consequence of a member having left the service of a railroad entirely and then allowing himself to be in arrears, you understand; and having done so he loses eligibility to membership. Then the question was brought up as to whether he could be restored, and we decided that he could not be without the adoption of this resolution.

MR. SETCHEL—If the President will remember there is a clause in the Constitution that expressly states that a member once a member remains a member until he resigns. Now, he does not resign. The Constitution simply cuts him off from the privileges of the Association and drops his name. He is a member until he resigns.

THE PRESIDENT—What would you infer from the reading of the Constitution—that a member should be dropped for non-payment of dues?

MR. SETCHEL—It simply drops him from the privileges of the Association. When he pays the dues he is restored.

SECRETARY SINCLAIR—The clause in the Constitution referred to is this:

"Any person who has been or may be duly qualified as a member of this Association will remain such until his resignation is voluntarily tendered or he becomes disqualified by the terms of this Constitution."

If he allows his dues to lapse and becomes dropped he is out of the Association. That is the way that I understand the clause.

MR. SETCHELL—I spoke in reference to what the practice had been heretofore, Mr. President.

APPOINTMENT OF COMMITTEE ON RESOLUTIONS.

THE PRESIDENT—I will appoint as a Committee on Resolutions John A. Hill, W. A. Smith and A. W. Gibbs.

TESTING LABORATORIES, CHEMICAL AND MECHANICAL.

THE PRESIDENT—We will proceed now with the regular order of business. The next thing in order is Number Three, Testing Laboratories, Chemical and Mechanical.

There was no report on this subject, and after considerable discussion, on motion the Committee was continued.

The next subject taken up was the report of the Committee on

EFFICIENCY OF THE LINK AS COMPARED WITH OTHER VALVE MOTIONS.

Your committee, appointed to investigate the subject, the "efficiency of the link as compared with other valve motions," beg leave to submit the following:

Circulars were issued to members containing a series of questions, to which thirty-seven answers were received. Twenty-eight report no experience with any other valve motion than the link.

Mr. Robert Bruce, M. I., M. E., Ethelburga House, 70 Bish-

opsgate Street Within, E. C., London, Eng., sends blue print of Morton's patent valve gear, also a paper describing same, read before the Institute of Marine Engineers. He writes:

"This paper deals particularly with Morton's system of radial valve gear as applied to marine engines, and points out the salient features of distinction, both in a mechanical and geometrical sense or aspect, between Morton's system and that of any other known form of radial valve gear.

"But with reference to locomotive practice, it has not yet been tried on a heavy main line engine, but within the next couple of months a full and severe test will have been made by a leading railway in this country with the gear fitted on an 18x26 in. cylinder—goods locomotive—which engine had been altered from the ordinary gear to the Morton system, for the special purpose of proving the principle of the latter form of reversing valve gear.

"I may say that so far as marine engines go, the cost of making, fitting up new, and of maintenance is in favor of the Morton system as compared with the common gear. The chief reasons, in my opinion, why the radial connecting rod system of valve gear should be insisted upon, especially in outside cylinder locomotives, are, first:

"The gear is all outside the frame and under the eye, so to speak, of the driver. There being in Morton's system no sliding dies or surfaces to contend with, and all the working surfaces being rotating surfaces, the friction is a minimum, and the advantage of Morton's working surfaces over sliding surfaces can be realized when we think of the surface given the crank pin for its strains, and the surfaces giving to the sliding of the crosshead in a marine engine for its strains.

"Sliding surfaces should be abolished in all cases where possible. With inside cylinder locomotives, the gear is all inside the frame, but there being no eccentrics, the crank webs may be made stronger. The valves come on top of cylinders and are easy of access when required to be looked at. Then, above all, the saving in first cost, and other facilities afforded by radial gear—the true and perfect source of motion in the Morton system—affords great advantage in giving equal port openings, and

constant lead for all grades of expansion, or for either direction of running. Furthermore:

"The path of actuating member of the system being oval instead of circular, the periods of admission and release of steam are longer, while the changes in direction of the valve motion are quicker than with the ordinary link, whose actuating eccentric follows the crank, while the actuating member in Morton's system follows the piston. These advantages in steam distribution all tend to economical working and increased efficiency, and further, it is only in Morton's system that these improvements are embodied."

No prints showing details of this motion were sent. The plan shows the motion to be similar to the "Joy" valve motion. It is claimed to have given good results on marine engines, but no indicator cards or result of actual work on a locomotive have been furnished. The device is open to the objection to motions of this class, viz., cost of maintenance.

Mr. David Clark, of the Lehigh Valley Railroad, sends blue prints of valve motion for main valve and independent cut-off combined. [This motion is illustrated in the Eighteenth annual report.] Also prints of indicator cards with and without the cut-off. He writes in explanation as follows:

"We have three passenger engines running with link motion for main valve and independent cut-off combined. My object in combining the cut-off with the link is to increase expansion and reduce compression when cutting off earlier than half stroke. I also get less lap to main valve, starting train quicker, especially on heavy grades, by the use of the link and independent cut-off combined. The compression is regulated by the link and the expansion by the cut-off.

"When the cut-off is out of gear and riding on back of main valve, it does not interfere with the link motion. The engine can be run with the link the same as without the cut-off applied. This gives two valve motions on same engine, and as yet I have not made any close comparative tests excepting with the same engine running alternate trips with and without the cut-off, and then by comparing the quantity of water evaporated.

"With the cut-off and link combined, the evaporation was 15 per cent. less than with the link. A part of this saving may be due to short lap of main valve, which is ¾ in. on either end. I have not kept an accurate record of the cost of application. I think it could be applied for $300. The engines it is on have been running an average of three years, and have had no extra expense in keeping in repair; in fact, the main valve does not require frequent facing on account of traveling nearly full throw when the cut-off is used.

"The cards show that the earlier the cut-off with the link, the greater compression, and thus far you can go until the pressure will balance in both ends of the cylinder. With the link and cut-off the back pressure or compression is regulated by the reverse lever, and the cut-off and expansion with cut-off lever, thereby using just the amount of steam required as the pull varies and sufficient compression to balance the engine at different speeds. On this division of our road, with stations close together, and heavier grades, I do not think it is of much advantage, but on long runs I would apply it to all engines, freight and passenger."

Mr. Ross Kells, of the New York, Lake Erie & Western, reports as follows:

"We have only made one test of locomotive equipped with a valve motion other than the link, and that test was to determine which of the two designs was the most economical on the basis of coal consumed per ton per 100 miles. We found on this test that our regular link motion locomotives were fully as economical on coal, and much more economical on maintenance of valve gear."

No description or plan of the valve motion referred to was forwarded.

Mr. H. A. Luttgens, Paterson, N. J., furnishes sketches and descriptions of three valve motions; the first two do not appear to have been put to actual service on a locomotive, but are an interesting addition to the history of valve motion. The third, known as "Uhry & Luttgens' Improved Link Motion," was applied to a locomotive on the Central Railroad of New Jersey,

Saratoga & Whitehall, Ohio & Mississippi, and Iron Mountain Railroads. Letters from officers of these roads in 1857, '58, '59, '63 and '64 generally speak well of this motion; though there does not appear to have been any tests made of its actual performance or indicator cards taken. There appears to have been trouble in holding the cam in place.

A saving of fuel is claimed. As the valve is reported to have had a 1⅛ in. lap, this result might have been due to the long lap. The drift of the letters is: That steam is admitted quickly at commencement of stroke. The impression of your Committee is: That this result could have been obtained fully as well by using valve with what is known as the "Allen Port," with no additional expense.

It has happened that one of your Committee had charge of a locomotive fitted with this improved link motion. The engine was a good one, but the cam could not be kept tight on the shaft. Screws, keys, and all known appliances for holding failed. After working with it for about a year, the cam and attachments were taken off and no perceptible difference was discovered in the working of the engine or in the consumption of fuel.

Mr. Luttgens states that: "In 1850, when the shifting link motion was introduced into this country by Mr. Thomas Rogers, it was not generally considered a perfect valve motion as compared with the hook motion, when operating independent steam and exhaust valves; but its simplicity and good wearing qualities enabled it to supersede the older motion.

"A combination of the link motion for working the main valve, with an independent cut-off valve, worked by a separate and adjustable movement, the cut-off valve being placed upon a separate valve seat, above an inner steam chest, which formed a compartment within the main steam chest, was applied to engines 'Chetwood' and 'Southmayd,' of the New Jersey Railroad and Transportation Company in 1859 and '60.

"The cut-off valve for 22-in. full stroke admitted steam at 4½, 5¼, 6, 7 and 8½ inch cut-off.

"The main valve, placed upon the regular valve seat, was operated by a common link motion.

"By means of this valve motion the admission of the steam could be changed, as well as the point of the exhaust, and independent of each other.

"On these engines it was found that with a short cut-off, a later point of exhaust than would result from the link motion when used alone, produced the best results in running the engine; but, notwithstanding this fact, no better results were obtained by the combination of the independent cut-off and link motion than by the use of the link motion alone, and with the same engine.

"This indifferent result was due to the inner steam chest forming, as stated above, a separate compartment; so that, while the cut-off valve indicated an admission of steam of 4½, it amounted really to some 9 or 10 inches; as the steam admitted into the lower steam chest expanded together with the steam in the cylinder, and the good results were lost which would have resulted from the combination.

"This fact that both movements produced about equal results is proof that the combined motion (without the defect of the extra steam chest) would produce better results than the link motion alone.

"The valve motion patented by Uhry and Luttgens in 1855 preserved the same features of independent adjustment of the steam valve and of the exhaust valve, without the intermission of a second steam chest, and also reduced the valve gear to less parts.

"This motion was never put into practical use.

"With a view to obtain a valve motion producing similar results with a single slide valve, and to be adjustable by a single reverse lever, we made a combination of the link and cam motion in 1855.

"Any desired result within certain limits can be got out of this combination; but, to make the back motion to carry the steam as far as the forward motion, the lower end of the link must be lengthened beyond the eccentric rod joint, so as to increase the movement of the valve at back stroke; or the cams must be constructed to partly revolve on the shaft.

"The movement without this admits less steam in the back motion than in the forward motion at full throw.

"This last motion was applied to locomotive engines two years before the issue of the patent, and was also used on certain experiments made by Mr. Horatio Allen in 1864 and 1865, for the United States Navy.

"Locomotive builders placed the cost of the application of this motion, in addition to the common link, at $500 per engine; $150 would pay for it at present.

"With proper care in design and construction, and used in connection with a balanced slide valve, this motion would prove very effective on fast passenger engines."

Valve motion, being a modification of the shifting link motion, patented March 20, 1855. It is operated by three eccentrics.

The motion operates two separate slide valves, which may be placed upon a continuous valve seat.

The central valve admits steam at and near full stroke, and is the exhaust valve.

The outer valve, which is made in two parts, united by a valve yoke, admits steam only.

The steam ports for both valves unite in passages at each end of the cylinder.

The exhaust valve is operated by a differential rocker, which receives motion from the link and also a third eccentric, and the steam valve is moved by the ordinary link motion.

The effect of the third eccentric upon the exhaust valve can be changed by moving the block in the lower slotted arm of the differential rocker.

The following table shows the result of this motion.

For comparison, a common link motion is represented by letter *z*, with a valve 5/8 in. outside and no inside lap.

The patented motion operated by three eccentrics is represented by

d' exhaust valve, with 1 inch outside and no inside lap.

c' steam valve, with 1 inch outside lap.

22 in. STROKE.

Steam Cut-off.	Travel.			Lead.		Opening of Steam Port.			Steam Port Open for Exhaust.			Point of Exhaust.			Compression begins.
	z	c'	d'	z	c'	z	c'	d'	z	d'	d'	z	d'	d'	z
20¼	5⅛	5⅛	3¾	1/16	1/16	1¼	1¼	1	1¼	1¼	1¼	21½	21⅝	21 13/16	21½
11	2 3/16	3¼	1⅞	¼	¼	set ½	⅝	0	13/16	⅞	1	18	19⅝	21½	18
7½	1 15/16	2 13/16	1½	5/16	¼	⅜	7/16	0	11/16	11/16	¾	16	17¾	21	16

Valve motion, being a modification of the shifting link. Motion, patented September 7, 1858. It is operated by two eccentrics and one cam.

This device consists of an ordinary single slide valve, which is moved by the combination of the common shifting link motion with a cam, the latter moving an auxiliary or differential rocker, which partakes of the movement of the link motion.

It reduces the motion of the valve at full throw, and increases the same at the points of shorter cut-off; it admits of a larger outside lap, say 1⅛ in., in place of ¾ in., without diminishing the admission of steam at full throw of valve, and modifies every function of the valve motion, giving:

Less pre-admission of lead.

Larger steam port opening.

Larger exhaust port opening.

Less compression if desired.

Later point of exhaust.

A quick opening of exhaust port and a quick closing of the steam port.

The action of the cam is auxiliary, and furnishes about one-third of the power to move the valve, which is small in amount, when moving a balance valve, as compared with a cam moving a common slide valve.

The cam is made of uniform shape. It is secured to the axle, and the setting of the valve is done by means of the eccentrics, the same as usual.

The following table was taken from this motion used on an

experimental engine at the Novelty Iron works, in experiments made by the United States Navy.

The small figures in this table give the result of the common link motion.

The underlined figures represent the link motion with cam attachment; it has 1⅝ in. outside and ¼ in. inside lap.

Steam Cut-off.	Lead.		Lead begins to open before end of Stroke.		Opening of Steam Port.		Motion of Valve.		Compression begins in per ct. of stroke.		Exhaust begins in per ct. of stroke.	
Per ct. 66	$\frac{1}{16}$	$\frac{1}{16}$	⅜ in. of revoluti'n of crank.	⅝ in. of revoluti'n of crank.	1⅛	1	$5\frac{9}{16}$	5¼	87.5	91	93.12	95
50	$\frac{1}{12}$	$\frac{1}{8}+\frac{1}{32}$	$1\frac{11}{16}$ in. of revoluti'n of crank.	¾ in. of revoluti'n of crank.	¾	⅞	5	5	80	87.5	83.75	93.7
25	⅜ set	¼	½ in. before end of stroke.	$\frac{3}{16}$ in. before end of stroke.	½	$\frac{11}{16}$	4⅛	$4\frac{11}{16}$	64.37	78.7	73.12	90

Mr. James Meehan, of Cincinnati, New Orleans and Texas Pacific Railway Company, reports as follows:

"I would say, in reply to the circular on the above, that I have only had experience with the link and old-fashioned hook motion, but from past observations I am fully convinced that the link motion for locomotive engines is the best yet presented for that purpose.

"All our heavy passenger engines are equipped with the link motion, with ⅞ in. lap., $\frac{1}{32}$ in. lead, Allen-Richardson valve,steam ports 1¼x16 in., exhaust ports 2½x16 in.

"In this connection, I would say that we have an engine built by the Rhode Island Locomotive Works which deviates from this practice, the travel of the valve being 6¼ in. I am fully satisfied that for engines of this class, the Rhode Island plan is the best."

Mr. T. W. Gentry, Master Mechanic, Richmond & Danville Railroad, reports as follows:

"A few years ago we made extensive experiments at our Manchester Shops with the "Joy" valve gear, applying it to two

ten-wheel freight engines (American Type), with 18x22 in. and 18x24 in. cylinders. The first application was made to an engine built by Rogers Locomotive Works, that had a very objectionable arrangement of the link motion, designed to dispense with the usual long eccentric rods or radius bars, which are generally curved to pass over and beyond front driving axle. After a patient trial under fair conditions we were compelled to abandon the Joy gear as entirely impracticable to this particular type of American locomotive.

"We, having another type of ten-wheel engine whose design we considered more favorable to the adoption of Joy gear, and being desirous of giving the appliance a fair and impartial test, we made another application, and notwithstanding the facts of very much better conditions and more ease of attaching and manipulating the several parts, and our experience gained in the former case, we had to also abandon this attempt. In both cases the engines did very fair work for a short while, but before we could get sufficient data as to performance, we were compelled to remove the Joy gear and re-apply the link motion, finding it utterly impossible to maintain the Joy gear rigidly in place, even after strengthening all parts that developed weak points.

"We attribute our failure to several reasons, mainly to vast difference in spread of centres of cylinders in American locomotives as compared with English engines, for which the Joy gear had been designed, and mostly applied to engines with 'inside cylinders.' We also found that the large amount of vibration and motion necessary to be provided for in our practice, to meet the great difference in permanent way and irregularities of our track as compared with most English railways, was much in the way of successfully maintaining proper adjustment, and the pitching and tumbling motion of the engine at high speed caused a very serious disturbance in the movement of valves.

"As a result of our extended experiments, we reached the conclusion that the 'Joy Valve Gear' might be a very good thing on locomotive engines designed with inside connected cylinders and crank axles, where centres of cylinders can be placed within a few inches of each other, and motion taken in nearly direct lines with main rods, and the whole gear swung under centre of

boiler at the point of least motion, and where, in order to get longer driving axle journals and wider bearings for main rod connections to cranks, it was desirable to dispense with the eccentrics, but that as a cheaper and more efficient and more practicable device than the ordinary link for our American locomotives, it was a failure.

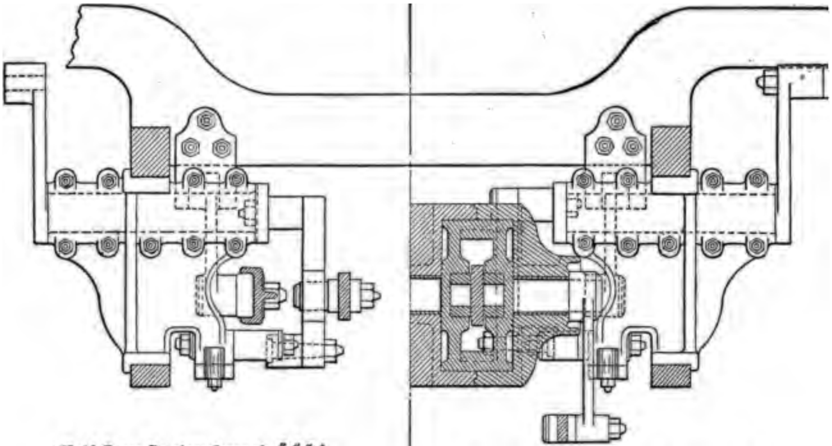
"We have had some experience with the 'Walshchaert' valve gear as applied by William Mason, of Taunton, Mass., to a narrow gauge locomotive, and after a fair trial we could see no advantage in the device over the ordinary link, and it had several objectionable features. It is fully as expensive, both in first cost and in keeping up repairs. It is much more exposed to damage by accident, particularly side collisions, etc., and is more difficult of adjustment and more affected by wear.

"We have also had experience with the ordinary link motion hung on the outside, and driven by suitable cranks attached to main pins. This arrangement is very objectionable for several reasons, and I would not advocate its use under any circumstances.

"In conclusion I will say that our experiments have shown us that the ordinary link motion, well designed and substantially applied, gives the most satisfactory results, and that in point of true economy it is probably the best and most practical valve motion in use to-day."

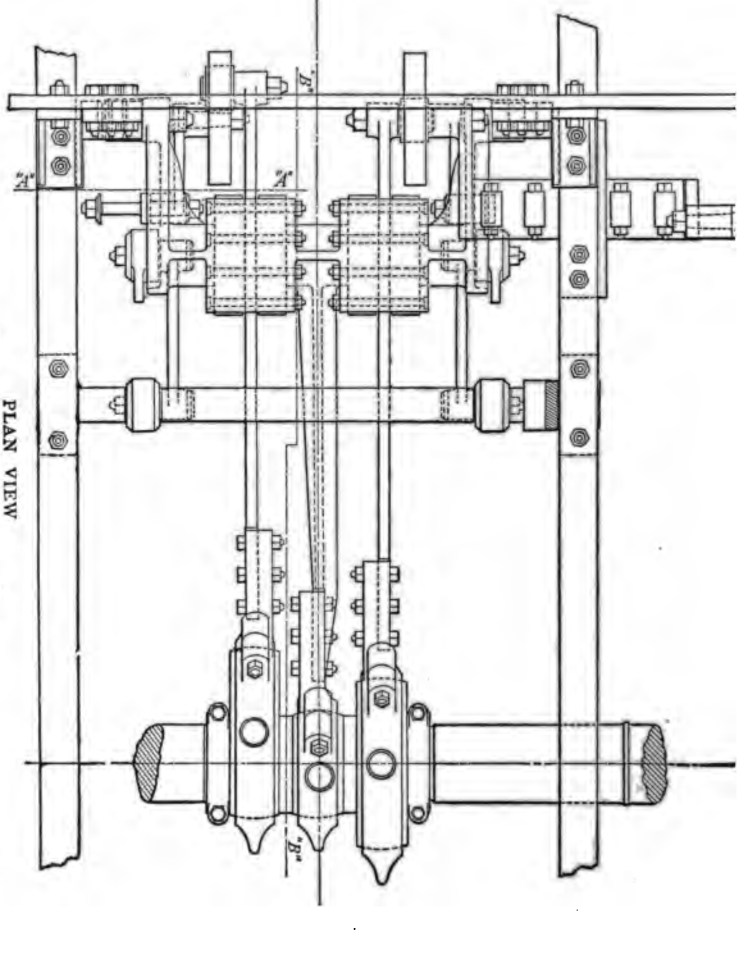
At the Fifteenth Annual Convention, June, 1882, Mr. Joy was present and explained his valve motion. Mr. Reuben Wells sent a diagram showing the action of the valve moved by link gear and same valve with the Joy motion, which was very interesting. This, with the discussion, was printed in the report of the proceedings of that meeting, and is well worth perusing.

Mr. Quackenbush, of the Chicago & Alton Railroad, furnishes blue prints of the "Wilson" valve motion as applied to Chicago & Alton engines 43 and 88; engine 88 having ordinary D valves, and two valves on each side, one controlling the admission and cut off, the other the exhaust. Also indicator cards from double-valved engine No. 43, while in regular service. We are indebted to the *National Car & Locomotive Builder* for the annexed illustration of the Wilson valve motion.

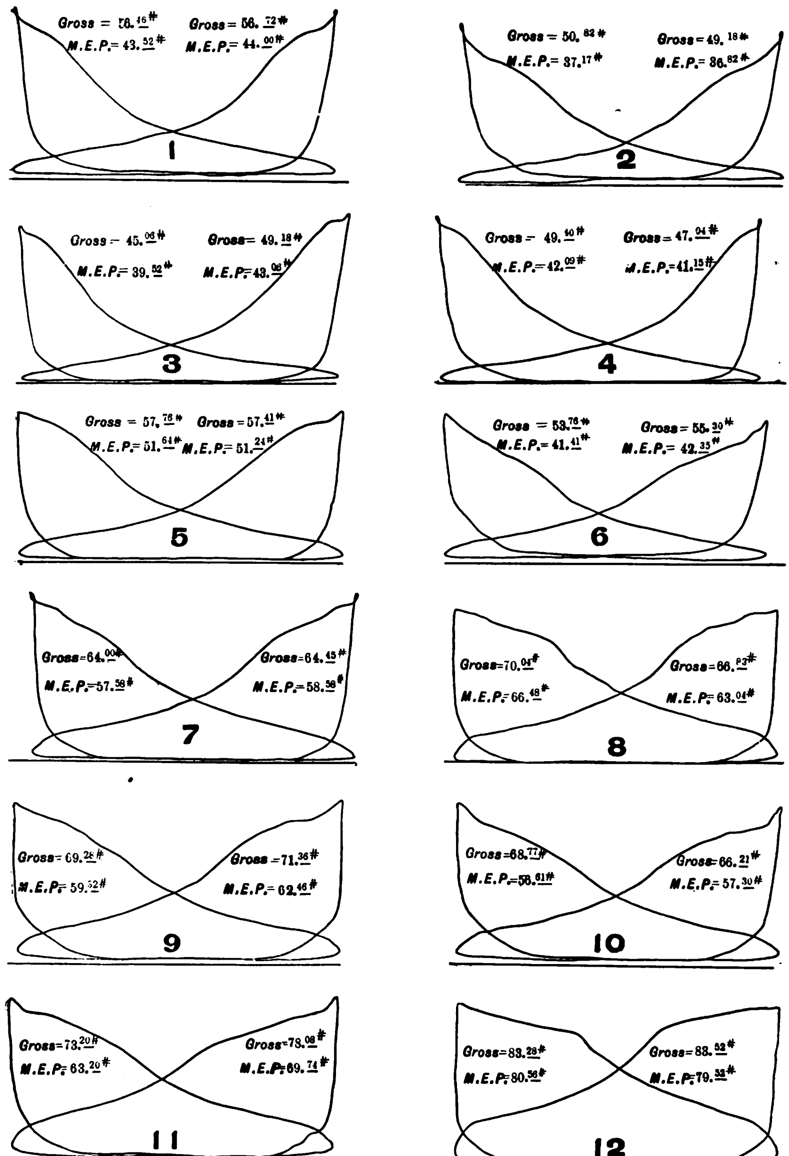


Half Cross Section through "A" "A". with Rocker Box left in position.

Half Cross Section through Centre of Reversing



PLAN VIEW
with Left Hand Rocker Box omitted.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M.E.P.= 63.20#
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M.E.P.= 69.74#
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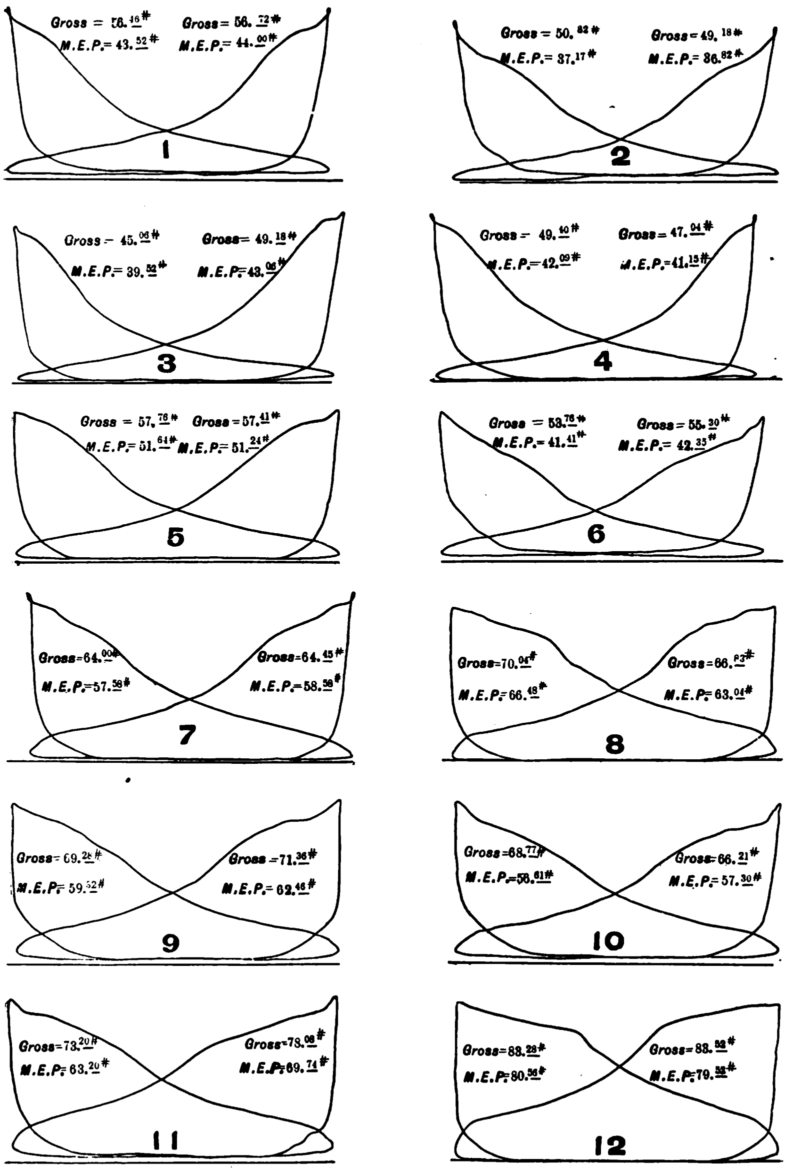
Gross = 83.28#
M.E.P.= 80.56#
Gross = 88.52#
M.E.P.= 79.52#
12

Plate 2a.

Indicator diagrams taken from locomotive No. 43, Chicago, Alton & St. Louis Railroad, equipped with Wilson's independent admission and exhaust valve gear. Engine cylinder 17x24 inches; lead of steam valve, $\frac{2}{10}$ inch; lap of steam valve, $\frac{33}{64}$ inch; lap of exhaust valve, $\frac{3}{20}$ inch. Indicator spring, 80 pounds to the inch.

No. of card.	Steam cut-off in inches	Exhaust opens.	Exhaust closes.	Speed in miles per hour.	Boiler pressure.	Initial pressure.	M. E. P.
1	4.59	21.6	19.3	49.98	140	137	43.76
2	4.59	21.6	19.3	61.6	135	126	37
3	4.59	21.6	19.3	35.4	135	129	41.3
4	4.59	21.6	19.3	37.5	140	132	41.6
5	6.5	21.6	19.3	36	135	127	51.46
6	6.5	21.6	19.3	66	135	126	42
7	6.5	21.6	19.3	30	140	135	58
8	6.5	21.6	19.3	25	135	130	64.8
9	8	21.6	19.3	40.3	140	138	61
10	8	21.6	19 3	44	140	136	57
11	10	21.6	19.3	38.3	140	138	66.5
12	8	21.6	19.3	23.4	140	133	80
13	10	21.6	19.3	36.7	135	133	73.7
14	10	21.6	19.3	22.5	140	133	94
15	12.4	21.6	19.3	12.5	140	139	104.2
16	12.4	21.6	19.3	18.3	140	135	104.5
17	14	21.6	19.3	15	140	135	106
18	14	21.6	19.3	19	140	135	110.3
19	17.4	21.6	19.3	12.5	140	137	117.4
20	17.4	21.6	19.3	17.4	140	131	114
21	19.6	21.6	19.3	9	140	136	120.6
22	19 6	21.6	19.3	12.5	140	136	126
23	21.5	21.6	19.3	8	135	132	122
24	21.5	21.6	19.3	9	140	134	123

Annexed engravings are from the indicator diagrams of the Wilson motion.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M.E.P. = 42.09#
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M.E.P. = 80.56#
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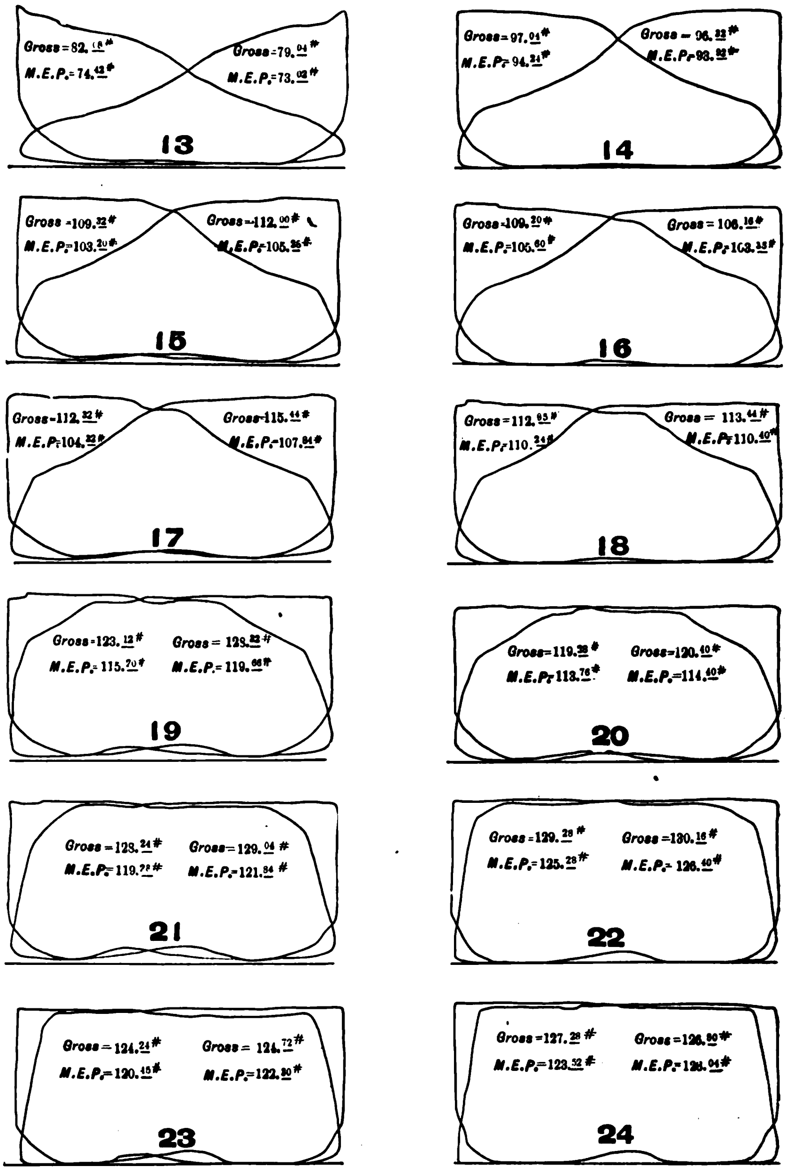
12

Plate 2a.



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Gross = 126.80#
M.E.P. = 123.04#
24

Plate 2b.

Mr. H. J. Small, of the Southern Pacific Company, reports as follows:

"We have on this system sixty locomotives equipped with the Stevens valve motion. [This motion was illustrated in the Eighteenth Annual Report.]

"The cost of fitting up new and applying the Stevens valve motion to a locomotive is twenty-five per cent. (25 per cent.) in excess of cost of the ordinary link motion with single slide valve.

"The maintenance of the Stevens valve motion is largely in excess of the ordinary link motion, while the general effect of the Stevens motion is to increase the total cost of repairs to locomotives.

"The very rapid admission of steam to cylinders by the Stevens valve results in severe shocks and strains to driving boxes, frames and rods, causing rapid wear and loosening of driving box brasses. Much difficulty is experienced in keeping the valves properly adjusted, owing to the greater number of wearing parts, and resultant loss of lead opening of valves, to the detriment of the engine.

"The Stevens valve motion is undoubtedly more economical in fuel consumption than the ordinary link.

"A comparison of performance of eight 18x30 in. ten-wheel engines with Stevens valve motion with an equal number of 18x24 in. ten-wheel engines with ordinary link motion, during the year 1889, on same division, as taken from performance sheets, shows the following results:

"The Stevens engines ran 281,144 miles, ninety-nine per cent. being in passenger service. The link motion engines ran 206,598 miles, fifty-six per cent. being in freight service.

"The Stevens engines show a decrease of eighteen per cent. in consumption of fuel and an increase of forty-one per cent. in cost of repairs. Taking the cost per engine mile for fuel at twenty-three cents, we have a gain of 4.14 cents per mile in favor of the Stevens engines. Cost per mile for engine repairs at six cents, we have a gain of 2.46 cents in favor of the link motion

engines, and a final net gain of 1.68 cents per mile run in favor of the Stevens valve motion.

"It may be of interest to state that the average miles run to one ton of coal by the Stevens engines above mentioned was 33.93, and by the link motion engines 27.92; from these figures it will be seen that the Stevens valve motion would be economical only where the cost of fuel is so greatly in excess of other items of locomotive expense as is the case on this coast."

Mr. Ellis, of the C., St. P., M. & O. R. R., writes as follows:

"We equipped an engine with the Woolf Valve Gear in May, 1889. It is an eight-wheel passenger engine with 61 in. drivers and 18x24 in. cylinders. The valves have ⅞ in. outside and $\frac{1}{32}$ inside the lap. The steam ports are 1¼x15 in., and the exhaust ports are 2¾x15 in. The exhaust nozzle is double, $3\frac{1}{16}$ in. in diameter.

"The engine has been running on our St. Paul division, hauling the Kansas City Fast Express, where the service is heavy, twenty-eight regular stops being made on this division.

"The gear is actuated by single eccentrics rigidly keyed to the axle in line with the crank pins. The straps have short arms projecting upward, which are pivoted at their upward extremity in rollers fitted to guides which control the movement of the straps at these points. These guides are attached to the extremities of a 'reversing' shaft, which is supported on carriers loosely boxed on the main axle. These carriers are maintained in an upright position on the axle by arms which project forward and are supported by hangers loosely attached to a counter-shaft placed in about the same position as the old lifting shaft. This counter-shaft has two arms, one connected by a rod to the reversing shaft, carrying the guide, and the other to the reach rod.

"The eccentric rods are connected directly from the rocker arms to pins rigidly fixed in the eccentric straps at a point offset from their centre line, for the purpose of securing an equal distribution of steam. The vertical position of the pin in the strap principally determines the amount of lap and lead motion given to the valves when the guides are central or neutral. The farther travel of the valves is secured by rotating the 'reversing' shaft, so that the guides stand at an angle to this central line.

"At the angle shown in the drawings the engine would be working at full stroke in the forward motion.

"This gear gives an alternating fast and slow motion to the valves, and thus secures a quick steam port opening and a prompt, clean release, with a proportionately short valve travel.

"On this engine when working at full stroke the extreme valve travel is 4½ inches, and the lead is virtually constant. The link motion engine making alternate trips with the engine equipped with the Woolf gear is otherwise of exactly the same pattern in every respect, and has an exceptionally good record, outranking any other in the service; but the Woolf gear engine has clearly shown its superiority in handling heavy trains at high speed, and at the same time runs lighter on fuel.

"Aside from the use in regular service for the past year, we have made no formal test to determine the exact economy effected by the Woolf gear, but there has been a marked saving, which is shown also by the fact that the engine is able to pass one of the four water stations without stopping. The gear seems to make a smarter engine and give increased speed.

"We have just equipped a second 18x24 inch passenger engine with the Woolf gear, and intend to equip a third, both of which are to run on our Chicago vestibuled trains.

"The cost of changing our engine, No. 72, from the link to the Woolf valve gear was $275. This is the actual charge for material and labor, and could be somewhat reduced if the work was done on a larger scale and became the general practice.

"My experience has been that the cost of maintenance of an engine equipped with this motion is no more than the link motion, and I am decidedly of the opinion that, as now constructed, with chilled cast-iron gibs and case-hardened rollers, the performance will show a considerable saving in repairs and maintenance, as compared with a locomotive of the ordinary link motion."

Your committee regret that no report has been received of the performance of the 'Strong' valve gear. The Strong engine has been in service on several roads, and the results obtained in comparison with the link motion would be very interesting.

Nowhere is the "survival of the fittest" more pronounced

than in railroad practice. The history of valve motions and devices to improve the link motion, and those that were to supersede it (?) would fill volumes. Many have been theoretically correct, and very promising, but, after the crucial test, have resulted in failure; and the link motion remains in almost undisputed possession of the field.

It has been urged against the link that it is not a scientific or true mechanical motion. This may be true, but the fact remains, that fairly good results are obtained from it; that it will take more punishment in the shape of rough usage and neglect, and cost less to make and repair, than any other valve motion now being experimented with on locomotive engines.

Your committee are led to believe that valve motions other than the link are experimental, owing to the difficulty of ascertaining data of the results obtained from them, excepting the "Stevens" motion, of which Mr. Small has sent full report.

The almighty dollar is always to the front, and no matter how theoretically or scientifically correct a motion may be, unless it costs less in every way than the link, it will not displace it. It frequently happens that the poor results obtained from a locomotive are charged to the valve motion, when the cause may be found in contracted steam passage pipes, leaky valves or pistons, steam wire drawn through the throttle, and back pressure, caused by contracted exhaust nozzles. It is surprising what a change will be made in the back pressure line of an indicator card by slightly increasing or diminishing the opening in the exhaust nozzle.

In conclusion, your committee are of the opinion that there has not been brought to their notice a valve motion more efficient for all-around work, and general utility, than a well designed link with large bearing surfaces—assisted in its work by steam passages and pipes of generous dimensions—free from sharp turns and bends—giving the link plenty and hot steam to distribute, and, most important of all, not crippled at the very end by a contracted exhaust nozzle.

JAMES M. BOON,
DAVID CLARK,
H. TANDY,
Committee.

DISCUSSION OF REPORT ON EFFICIENCY OF THE LINK MOTION.

On motion the report was received.

Mr. Luttgens—It says here that "saving in fuel is claimed. As the valve is reported to have had 1⅛ inch lap, this result might have been due to the long lap." This motion is precisely the same at 6 inch cut-off as an ordinary link motion at 11 inch cut-off. Therefore, the result is not on account of the increased lap.

On motion, the discussion was closed.

RELATIVE VALUE OF MOGUL AND TEN WHEEL ENGINES.

The President—Gentlemen, our noon hour is so near that it is not worth while taking up any other subject than the one dropped yesterday. The question of the mogul and pony truck was up and we postponed that until to-day. We will now resume that subject.

Mr. Setchel—There is a gentleman present who, perhaps, has much more experience with the pony truck than any man in the Convention. I refer to John Campbell of the Lehigh Valley. I should like to hear from him.

Mr. Campbell—I have had more experience, likely, than any other man in the last twenty years in this matter. I would not under the circumstances recommend a single truck for fast passenger service. We have had no accidents. I do not know of an accident happening with a single truck. Of course, I think there is a great deal more side vibration with the single truck than the four-wheel truck. I cannot report any accidents in the last twenty years.

Mr. Peck—I had charge of moguls for about six years. I consider a single truck safe, as far as my experience goes. I would not be afraid to run a single truck pony wheel anywhere from what I have seen. I have never had one to run off the track.

Mr. Roberts—It seems to me that there has been a prejudice against the pony truck without any particular reason for it. The principle doesn't look altogether right at first glance, and perhaps we are ready to condemn it because it has not got enough wheels in it. Now, we have called up this question, and my old friend, Mr. Setchel, stands up and recommends the ten-wheeler over the mogul, and the safety of the eight-wheeler over the pony truck. The members are called upon to answer the question if they know of any trouble with a pony truck, and we find that the Convention fails to give one single case. There are very few roads but have gone to the front with consolidation engines, and do not hesitate to put them into service as heavy freight engines, and they have all got pony trucks. Now, if the pony truck is used as much as it is without any accidents, I will ask why is the ten-wheel engine preferable to the mogul engine, when we can arrange the valve gear

without having to make bends and intermediate connections to get to our valve motion, where we haven't complications in connection with our guide arrangements, where we have a flexible wheel base that we can arrange from 13 feet 2 inches or less up to 15 feet, whatever the curvature of the road demands? I would like to ask what reason there is that the mogul has had to take a back seat all these years? We find that there isn't anybody to say that the pony truck is a bad thing. I would like to hear a little further on that.

THE PRESIDENT—I would like to ask Mr. Roberts if he can give me the mileage that those pony truck wheels under his mogul engines make?

MR. ROBERTS—I do not believe I can give that information exactly, not having carried forward any data, but I believe I would be safe in saying that the wear on the wheels of the pony truck does not exceed that of the front pair of wheels on a four-wheel truck of a ten-wheel engine.

MR. GRIGGS—I have had mogul engines in use now for nineteen years, and I never have found any trouble in curving, no matter where you put them. I use them on a road that has not a mile and three-quarters of straight track on it. As to the flange wear, I agree with the gentleman who just spoke, that the mileage made with the pony truck wheel was equal to any truck on any engine on the road, unless there was something wrong about it, when it was searched for and altered. I use them on passenger trains running thirty-five miles an hour month in and month out and experience no trouble.

THE PRESIDENT—I would like to hear from Mr. Leeds on that subject; he ought to be pretty well posted in regard to that.

MR. LEEDS—We have got hundreds of consolidations and moguls. I am not afraid to ride any of them at any speed you can get out of them. At the same time I have just specified some ten-wheel engines, believing that moguls are absolutely safe, believing that one pair of wheels with a properly proportioned pony truck adjusted right, will run just as long as the two pair of wheels in the ten-wheeler, although your forward drivers have to do part of the curving, and will wear their flanges faster at almost any wheel base, unless you put your links at such an angle as to almost make it a rigid truck. That is the only danger in your forward drivers, so far as I know. But conceding all that I want to get something heavy, something that I can put a 19x24 inch cylinder on. So far as I confine myself to an 18x24 cylinder I couldn't get anything better than an eight-wheel engine. Everything could be carried nicely without carrying beyond 16,000 pounds to the driver. So confining myself to the weights that I considered right to put on my drivers, I first proportioned out what I considered a pretty good 19x44 inch cylinder engine. I found that I had got to carry about 118,000 pounds. Putting 30,000 to 34,000 pounds of that on to my trucks, still left me more weight than I could utilize with anything over a 60-inch wheel. When we pass beyond 18-inch cylinders and proportion the boiler to supply them with steam, we begin to get excess of weight on drivers. When the cylinders come to be 20 inches diameter, the engine must weigh from 127,000 to 128,000 pounds and that is too much weight to be distributed properly on three pairs of drivers and a pony truck.

Consequently it looked to me as though the question resolved itself, into the using of the ten-wheel engines for a high speed engine, because with that type of engine the weight could be distributed to the best advantage. In the first place we don't want anything but the eight-wheel engine up to 18x24 inch. Above that we want the four-wheel truck to carry the excess of weight that we are obliged to have in order to have the boiler of proper proportions to make all the steam that is necessary. As to the safety, I never have seen the least bit of trouble.

MR. FORNEY—I see Mr. Cromwell and Mr. Weisgerber of the Baltimore & Ohio Road. The Baltimore & Ohio has better opportunities to get information regarding this subject than any other road in the country. That is probably the crookedest road in the United States. They have a great many consolidation and mogul engines, and I wish one or both of those gentlemen would give us some information.

MR. A. J. CROMWELL—I would say on the Baltimore & Ohio we have 200 engines of the consolidation and mogul type with pony wheels. The first engines we received were consolidation engines with a bald tire on the front wheel, and the second and rear wheels unflanged. They were operated on the Third Division of the Baltimore & Ohio Railroad where the curves are very short. We had known them to drop their front tire at certain times in the day and it put our track in pretty bad shape. We then changed the tire and put the flanged tire forward. We then could keep them on the track, but the front flange was inclined to wear more rapidly, or wear very rapidly after we made that change, showing that the truck failed to lead the engines around the short curves.

THE PRESIDENT—Was that a rigid truck on those engines?

MR. CROMWELL—It was a springing pony truck, springing on links such as we are discussing in connection with the mogul. After the change was made with the tire we had no further difficulty and haven't had to this day. But we were running a ten-wheel engine on that same division with a four-wheel truck. The wheel base was the same, within about 7 inches. They never left the rail and are running there yet, which would convince me that the four-wheel truck would be safer than a pony truck. I never knew of the pony itself getting off, and I have often ridden on the engine, and I do not think that the pony does all the guiding as the wear of the flange wheel would show.

There is another point I haven't heard any of the members speak of about the pony of the mogul engine. We had to guard them very closely to get them to run on the line of the track. They inclined to run either to the right or left more than any engine I had experience with. A very little deviation in the length of the links, and a very slight difference in diameter of tire, (I say tire because our truck wheels are tired) would cause this trouble of running to either the right or left, and I also noticed on our moguls, that the front flange wheel wore more rapidly than the rear or any other wheels of our engines. As to the wear of the truck tire itself on the mogul and four-wheel engines, I failed to see any difference in their wear as compared one with the other.

MR. SETCHEL—My friend Roberts quoted me rather strongly. I did not say that I thought the four-wheel truck was better or safer. It is a matter of question with me. My friend Forney is designing an engine and he has come to the truck, and it was a question with him as to whether the pony truck was safe at high speed. He comes here and asks the expression of the Convention. Now, that is just the position I am in exactly. In meeting railroad men as a locomotive builder, that question is often asked and there is a fear in the minds of railroad men that the pony truck is not quite safe. There is a belief among car builders that the six-wheel truck is safer than the four-wheel. Why? Because there is more surface to distribute the the wear over. It would hardly be be quite good practice in building Pullman sleepers or officers' cars, or any important cars not to build a six-wheel truck. Now, it is a question whether this apparent safety of the mogul truck at high speeds is not because of the superior condition of our tracks.

Mr. Griggs says that he has used them for 19 years, running up to 35 miles an hour. Thirty-five miles an hour is not a very extravagant speed in itself. We run freights 30 and 35 miles an hour right along. But when we come to talking of 60 miles an hour, then the question arises, is the pony truck a sure guide to an engine of that kind? Do we feel as perfectly safe? Nobody can deny that you get a better distribution of the weight; that you can better arrange your machinery. But that is not the point that Mr. Forney brings up. The question is, is it safe, and I think the very fact that has been admitted generally, that there is more wear with the single pair of wheels, proves that the four-wheel truck arrangement is the safer one for high speed engines.

MR. ROBERTS—I am inclined to believe that the increase of danger in the running of a mogul engine with a pony truck is more attributable to the length of wheel base than it is to the pony truck, and I believe also that the wear of the flanges of the front tires is attributable largely to that particular cause. Take an engine of that class and with a very long wheel base it will not do good service; but by reducing the wheel base to meet the requirements and the curvature of the road, the engine will be made to work satisfactorily. I cannot at present admit the fact that the mogul engine is not as safe to ride on as an eight-wheel engine, and I would not hesitate from my own experience with them, and the record that I have of them, to man one of those engines and run it as fast as I would an eight-wheel engine, provided the wheel base is not too great. It is true that in connection with the ten-wheeler there might come in this point, that we could carry a larger boiler and have the same weight on our drivers. It may be an advantage in that respect that we can carry those large boilers with less wear on our journals, perhaps.

MR. MCCRUM—There is one point that interests me very much in reference to the mogul engine as compared with the ten-wheel engine—that is the relative wheel base. This gentleman who has just preceded me speaks of the advisability of contracting the wheel base of mogul engines, and Mr.

Mackenzie referred to this matter yesterday. Now, we assume, that the relative difference of engines of the same gross weight between the ten-wheel type and the mogul type is about 12 per cent. as ordinarily constructed. Now, if it has been demonstrated in practice that the ordinary mogul engine with a wheel base of perhaps 15 feet and with a pony truck, is defective on some roads in the way of cutting the flanges, how much is it necessary to contract the range of the wheel base in order to obviate in a measure at least that trouble, and assuming that it is necessary, when you have done it, how much weight in excess of the standard ten-wheel engine of the same gross weight have you? I will admit the point made by Mr. Roberts in the matter of the motion being suspended between the two wheels. I think there is more in that than any other thing pertaining to the whole matter. That I like, and it would be the only reason that I would advocate the mogul engine in preference to the ten-wheeler, but I do not believe there is enough advantage in general in the mogul engine over the ten-wheel engines to recommend it.

Mr. Barr—I think if we could get a few facts on this matter for the purpose of comparison, it would help us in arriving at a conclusion. Now, there are a few observations that I have made in the matter of failure of the four-wheel truck on the front end of the engine. In one case a train arrived in Washington and ran into the depot, and when the engineer looked over his engine he found 28 inches of the flange of the truck-wheel gone. They immediately made a search for the piece of flange and found it more than 20 miles back, so that the engine had evidently run 20 miles with 28 inches of the flange gone. That was a four-wheel truck. The question very naturally arises, suppose that had been a pony truck, would there have been any more liability to derailment of that engine?

Now, I have another case that occurred about three or four months ago. A switchman in the Chicago yard saw a piece of flange about 15 inches long in a frog. One of our principal trains had just passed and he called the attention of the telegraph operator at the place to it, and he telegraphed ahead and he had that train stopped about 12 miles from the point where that piece of flange was found. The engineer was not aware of the fact and the wheels carried the engine safely that distance. How much farther they might have carried it I don't know. These were both cases of very fast moving passenger trains. I have also on record at least five cases of fast moving heavy passenger engines, in which the flange broke and derailed the engine with a four-wheel truck. In one case it was a back wheel, in all the other cases the forward wheel. Now, I don't think from these six cases, that this Association would be justified in coming to the conclusion that the four-wheel truck was more liable to produce bad results or less saving than a pony truck, although the examples would seem to tend that way, and the general feeling of the Association seems to be, that there has been no development which shows the pony truck to be dangerous. Now, when we look at the fact that there are thousands of fast passenger engines running with four-wheel trucks and possi-

bly tens running with pony trucks, the experience that we have had with the two kinds of trucks is very disproportionate. I haven't any doubt that almost all the members of this Association have seen cases in which derailment has been produced by reason of the failure of the four-wheel truck, and when we have had a similar kind of experience with the pony truck, in engines making similar speeds and under similar circumstances, it is almost impossible to say what the results may be, but I, for one, am still inclined, even in view of the failures which I have seen, to think that we are a little safer, if not considerable safer, with the four wheels there than with the two wheels.

MR. MCCRUM—I move that the discussion be closed.

MR. MACKENZIE—Before that motion is put I would like to ask Mr. Barr in connection with those trucks, if they were not all cast iron wheels?

MR. BARR—All cast-iron wheels.

MR. MACKENZIE—I do not believe there is a passenger engine of the mogul type today that is running with a cast-iron wheel in the front end. They dare not do it. (Applause.) Now, I want to say about the mogul engine —the question that started us on the mogul engine was just what Mr. Leeds brought out. I was an advocate of the ten-wheel engine, and when it came to the limit of weight I wanted a larger boiler which I could not get in the ten-wheel engine. I was allowed to carry 100,000 pounds and no more. What was I to do! They wanted a large cylinder. The boilers we had on our ten-wheelers were too small. We were satisfied of that. In order to get the engine we wanted, we took the extra weight of the truck and put it in the boiler. What has been the experience with us? The experience has been that we can run a truck wheel in our mogul engines more than 20,000 miles without renewing, taking the truck wheel out and turning the steel tires. Why did we put steel tires in there? Because we did not think the cast-iron wheel was safe in that position. When I say flange wear I speak particularly of the front truck—not of the driving wheel. We do not experience any trouble with flange wear on our driving wheels. In order to demonstrate the trouble that was with this truck, we stripped one of the engines and went through her in every way, and we could not discover that there was anything wrong with the truck except that the hangers were too short as we thought. We lengthened the hangers, and the first trip she made she went over in a ditch, caused as I claimed by a bad frog, the engineer said it was not a bad frog, but when the frog was repaired it went over all right. But we are not afraid to run those engines fast, because we watch the flanges on the wheels and keep them in perfect order. We do not allow to them to sharpen at all. We never have had any of the engines derailed on account of fast running or with the pony truck.

THE PRESIDENT—Did you notice an excessive flange wear on that pony truck?

MR. MACKENZIE—Yes, sir, an excessive flange wear.

MR. MCCRUM—I would like the sense of this Convention on the question

Mr. Barr raised as to how far that engine would probably run if she had lost 18 inches of the flange on a pony truck, and in connection with that idea I would say that the seeming necessity for maintaining more carefully the condition of the pony truck wheels, is evidence that they do not feel quite so safe with the pony truck as they do with the four-wheel truck. I am not here to condemn mogul engines, because I have never had any experience worthy of mentioning with them, but I was asked to decide that question seven or eight years ago for our people as to whether we would have mogul engines or whether we would have ten-wheel engines. Well, from my observation up to that time I was in favor of the ten-wheel engine. We adopted the ten-wheel engine as the standard freight engine, and as yet I have been unable to see enough merit in the mogul engine over the ten-wheel engine to recommend its adoption. We have had a free expression of opinion from this Association, and I question very much whether any further information that would be of value to the Association would be obtained by any further discussion of the matter, and I would move the discussion be closed.

The motion was seconded,

MR. SETCHEL—I wanted to test the opinion of this Convention in regard to what Mr. Forney has asked, and it is due somewhat to ourselves to give an expression in the matter. Now, with the distinct understanding that, personally, I think the pony truck is not as safe at high speeds as a four-wheel truck, I move that it is the sense of this Convention that the pony truck is as safe under the front end of a high speed passenger engine as the four-wheel truck.

MR. FORNEY—Before that motion is put I would like to say one or two words on that subject. I didn't propound the question with a view of getting at the relative merits of mogul and ten-wheel engines. The engine I was designing was neither a mogul nor a ten-wheeler ; but I wanted to use a pony truck in front. While in this country it is true that pony trucks are not used to any considerable extent in front of passenger engines, in Europe the case is quite different. The larger proportion of engines they are running on fast passenger trains have a single leading wheel or pony truck. They are used under engines that are running at as certainly high speeds as any in this country. I think Mr. Webb's compounds have what is substantially a pony truck in front. If they can use a pony truck on the other side I cannot see why it is not safe to use it in this country. But at the same time I found there was a prejudice among Master Mechanics and railroad men against it. That is why I propounded the question. Mr. Setchel, it seems to me, is arguing a little as the patient did about the pills the doctor prescribed. The doctor prescribed two pills. The patient argued that if two pills were good two more would be still better, and he finally wound up by taking the whole box. I do not think that if two wheels in front of the engine are good that therefore four-wheels are better. It may be that a two-wheel truck is safer than a four-wheel truck. I wanted to get some light on that subject.

The motion to close the discussion was then put and carried.

The next business taken up was the reading by the Secretary of the report of the Committee on

THE ADVANTAGES AND DISADVANTAGES OF PLACING THE FIRE-BOX ABOVE THE FRAMES.

Your committee, to which was referred the subject of "Advantages and Disadvantages of Placing the Fire-Box Above the Frames," respectfully submit the following report:

There was issued to each member of our Association a copy of this circular:

"1. Do you consider it an advantage to place the fire-box above the frame? If so, please state your reason.

"2. Do you experience any more difficulty in keeping mud rings and flues from leaking when above frame than when below?

"3. State the distance from bottom of mud ring to bottom row of flues.

"4. Is your ring set level or does it drop in front? If so, how much? If you drop in front, please state your reason for that method of construction.

"5. Are your mud rings double riveted all around or only in corner?

"6. In placing the fire-box above the frame, does it run straight across or drop in middle?

"7. What depth of fire-box would you recommend?

"8. Does your fire-box stand level, or do you dish your frame toward the front end?

"9. What increase of grate surface do you obtain by raising fire-box above the frame?

"10. Do you experience any more trouble with driving boxes heating with fire-box above frame than between?

"11. Do you have any more trouble with flues stopping up with fire-box above the frame than below, and what is the diameter of flues used?

"12. Do you use water bars or grates, and for what kind of coal?

"13. Do you use brick arch with fire-box above frame?

"14. Please state in a general way what advantages or disadvantages, if any, you have derived from placing fire-box above the frame."

We received forty-five replies, of which twenty-four were merely acknowledgments of the receipt of circular or were noncommittal, giving little or no information which would aid the committee in arriving at any reliable practical conclusions. Most of the answers were given in such a general way that it was almost impossible to get down to details. We do, however, feel very much indebted to a few members who, we are satisfied, did their best to help us. Seventeen persons expressed themselves in favor of placing the fire-box above the frames, principally to gain the 18 per cent. to 20 per cent. of grate area, one member claiming as high as 50 per cent., which of course applies to the Wootten fire-box. We understand that our investigations apply to the simple process of placing the fire-box above the frames, without lengthening it or widening it beyond the edges of frames. There were five persons who did not see any advantage in placing the fire-box above the frames. These members were either burning soft coal or were not working their engines up to their full capacity, and under such circumstances of course they could not realize very much, if any, benefit from a change of their usual practice. Thirteen members had no more trouble through tubes and mud rings leaking with furnace above frames than between frames, while four did experience trouble from both. In these instances the water was bad, or the furnaces were so shallow that the fire was banked up against the flue sheet, so as to entirely stop several of the bottom rows of tubes. The greatest distance recommended from bottom of mud rings to bottom row of tubes varied from 42 inches for soft coal to 16 inches for anthracite. The average was 22 inches. Five members drop the mud ring at the front end, and eleven make theirs straight or level. Fourteen report single riveted mud rings, one double riveted, and two double riveted at the corners only. The mud ring is dropped in the middle at the front end between frames by three members, while twelve make them straight across or level. The depth of fire-boxes recommended varies from 60 inches down to 42 inches at back end and 48 inches at

front end, which is nearest to the average. But one has had any trouble from driving boxes heating, and that was due to an imperfect ash pan, which permitted the ashes to fall on top of the driving boxes. Fourteen have had no trouble from flues (which are all 2 inches in diameter) stopping up, with furnace above frames, and four have had. In all of the latter instances the distance from bottom of mud ring to bottom row of tubes was less than 20 inches. Cast iron grates are used by fourteen members, mostly for bituminous coal, while four use water bars for anthracite coal. Brick arches are used by seven, with bituminous coal principally, and ten do not use them.

In the year 1835, Pambour, in his "Treatise on the Locomotive," uses the following very suggestive language: "It is in the fire-box and boiler that resides the real source of the power of the engine. From thence results all the effect produced. The cylinder and other parts are the means of transmitting and modifying the power; but what could be their effect if that power itself did not exist?"

In 1855, we find D. K. Clark quoting, in his valuable work on "Railway Machinery," this identical language, and we present the same sentiment today for your careful consideration, but we hope that our experience has brought us nearer a correct solution of that problem than were those eminent engineers whom we have quoted. In his "Physiology of the Locomotive," the eminent author, D. K. Clark, shows that he had brought the physical conditions of combustion in the fire-box down to as fine a condition as was necessary with the work that those engines had to perform. While some of the general principles are strikingly similar, the details of that practice were far different from those of today. As, for example, thirty years ago from eight to ten passenger cars were all that a locomotive was expected to haul, and they were very light compared to our heavy coaches of today. The speed was about thirty miles per hour, which was easily accomplished with engines having 16"x24" cylinders, and driving wheels 5′ to 5′ 6″ in diameter. A fire-box five feet long and a boiler with 850 to 900 square feet of heating surface was considered "monstrous." These conditions are all changed now, and we are compelled to haul ten to fifteen

heavy coaches at a speed of forty-five miles per hour. It requires but a moment's reflection to realize that the work we are doing in foot pounds per hour is upward of three times what we did with the former engine at the former speed. Then the best of fuel was used, but now the object is to use the cheapest fuel; so we are required to have a boiler with more than three times the heating surface to do our work; or, in other words, we ought to have at least 2,800 square feet of heating surface. We are troubled for want of steam, and to meet this emergency many plans and ideas have been suggested, and still we find that we cannot get where we wish to be. In marine and stationary boilers, the rate of combustion is cut down as low as possible, say fifteen pounds per square foot of grate per hour; but in the locomotive we try to burn as much fuel as possible per square foot of grate, and this runs up to 150 pounds and often more. Thus we see that the locomotive is forced away beyond the economical limit, and cannot be compared with the two classes of boilers named above for the economical use of fuel. Modern passenger locomotives are usually built with frames 43 inches apart, as shown in Fig. 3 of the accompanying engravings (which is one of four furnished by Charles Graham, Delaware, Lackawanna & Western Railroad). Then, allowing for wedges and clearance, we have 41½ inches outside of boiler and 34⅛ inches width of fire-box. When placed between the axles, the length is then limited to six feet eight inches, about, according to style of engine; but the engraving shows the average practice, in which case we have 25.59 square feet of grate surface. Now we take the same engine and cut off the frame, as shown in Fig. 4, and make a splice in the frame back of main pedestal jaw, dropping it about 7 inches. The rear part of frame is depressed so as to permit the boiler to hang as low as in the previous instance. It will be observed that the distance from bottom of mud ring to centre of bottom row of tubes is 25⅜ inches in both examples. The water bars have a pitch of one inch to the foot, which insures free circulation of the water. A slight offset is made sidewise in the frames, just back of the splice, so that the frames back of that point are 42 inches apart. The fire-box is also 42 inches wide, the frames being 50 inches outside, as shown. The object in thus

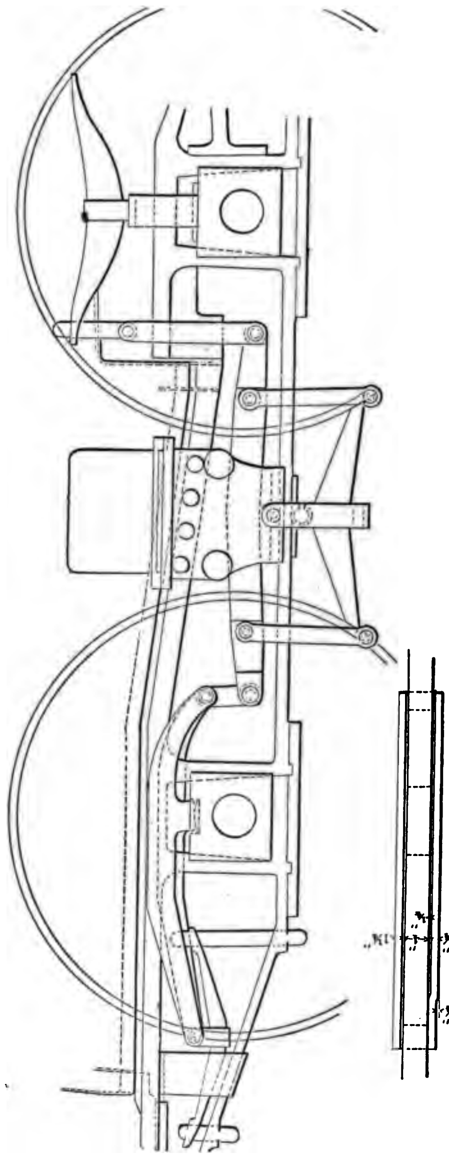
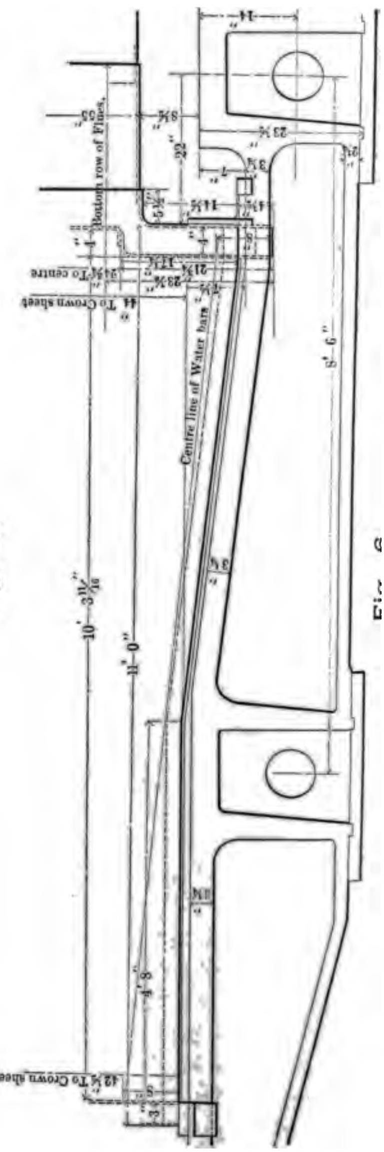


Fig. 5.



Bottom row of Flues.
To centre
To Crown sheet
Centre line of Water bars
To Crown sheet

narrowing up the frames, is to make room for the equalizing beams, which, through the alterations already made, have to be placed between driving wheels and frames, as will be understood by an inspection of Fig. 5, which shows the manner of spring hanging and equalizers. In this boiler we have 31.5 square feet of grate surface instead of 25.59 square feet. All things considered, we gain about 23.1 per cent. by placing the furnace over the frames, as here shown. The driving boxes can by this arrangement be made to cover longer journals, thus increasing their durability and reducing the probability of overheating. In Fig. 6 we have a new frame as designed for engine No. 158 of the Delaware, Lackawanna and Western Railroad, with fire-box above the frames.

The idea of lengthening out a fire-box beyond certain limits, in order to secure a larger grate area, is objectionable, unless a brick arch in the furnace be used to deflect the gases backward, so as to better utilize all of the heating surface of the crown sheet. Without such an arch, the gases, in rising from the surface of the fire, are compelled to assume the form of an hour glass in order to squeeze through the tubes. We are fully convinced, therefore, that it is better to place the fire-box on top of the frames, and gain the desired grate surface by increased width rather than by length. This style of furnace is being received more favorably every day, and the prejudices that used to appear against it are not heard so frequently. Some of the more conservative of our railroad officials have adopted this method of attaining the desired object. The depth of furnace at the front end is an essential matter, and we find that where the distance from top of grates is less than 20 inches, the lower tubes are invariably stopped up by fuel being drawn into them; and we have seen fire banked up in such a fire-box so as to cover five or six rows of tubes. We advocate not less than 20 inches, and more when it can possibly be had. The argument which we so often hear against the wide fire-box, that it necessitates the hanging of the engine from the bottom, has no weight, because it is well known that an engine hung from the under side of the driving boxes rides very much easier than the one with springs on top of frame. We know where this change was made, and

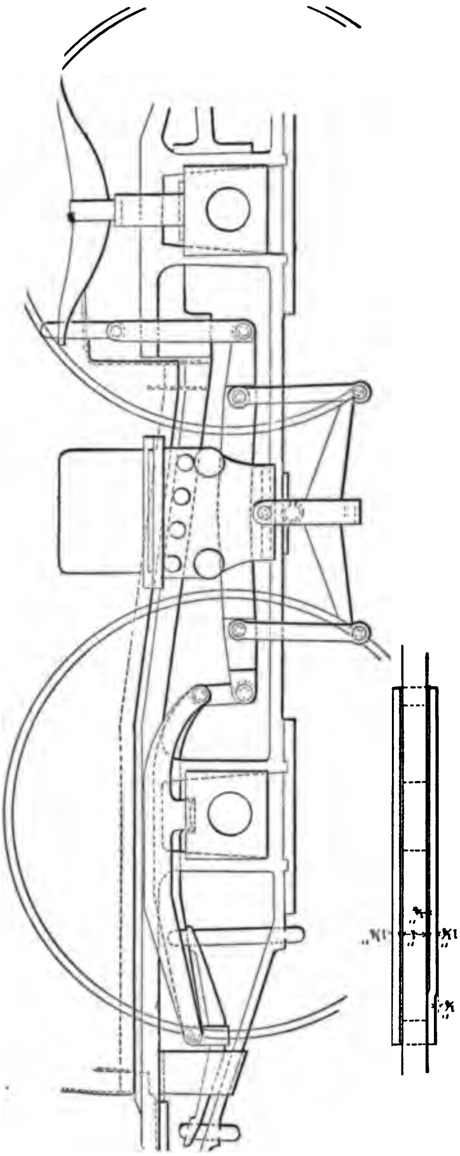


Fig. 5.

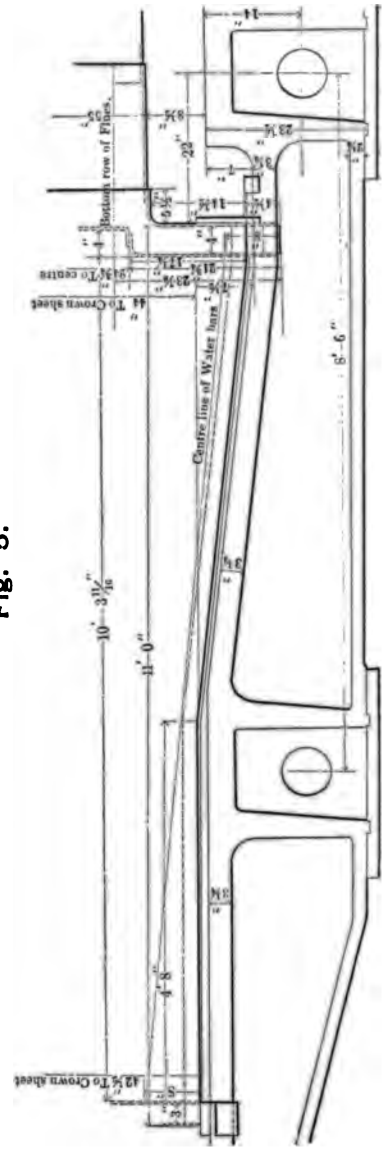

Bottom row of Flues
To centre
44" To Crown sheet
Centre line of Water bars
10'-3 11/16"
11'-0"
6'-6"
4'-8"
42 ¾ To Crown sheet

Fig. 6.

the engine ran very much easier afterward; besides, the springs and equalizers are in this case more easily handled than when hung from the top. The cost of spring rigging, all things considered, is no more in the former case than in the latter. It is well known that raising the boiler so slightly as is required does no harm, but is rather a benefit, because every one who has ridden on a Wootten locomotive could not help observing the ease with which it passed around curves. When an engine leaves the track one design is about as likely to roll over as the other, or at all events we never knew them to stand upon ceremony. It is also urged that, with the fire-box above the frame, the mud ring cannot be calked. If the mud ring is properly put in, there will be no need of calking, for a member of your committee has tried the plan shown in Figs. 7 and 8 on several locomotives during the past year, upon the Buffalo Division of the Delaware Lackawanna & Western Railroad. The mud ring is made thick at the corners, so as to put in a double row of rivets, as shown. No leaks have as yet occurred with mud rings applied as here represented. The water used in these boilers is probably as bad as any in this country, for it is impregnated with sulphuric acid, and forms a hard scale, principally of sulphate of lime. A question may be suggested in reference to double riveting all round, but that involves the subject of boiler construction, with which this committee has nothing to do at present. The spring rigging on this engine is easily reached, and it is found that, with the centre of gravity high, the lateral motion does not so readily appear, and that the wear and tear of the running gear is under those conditions very much less than when the boiler is set low in the frame. With single riveted mud rings, these engines gave no end of trouble, but with the double riveted corners they do not leak, or, in other words, the disease in this case is cured by the remedy described.

In summing up, the evidence proves that with the fire-box above the frames, the combustion is very much better than when between the frames; and larger nozzles may be used, thereby lessening the objectionable back pressure upon the exhaust. Cheaper fuel may be used, other things being equal. More water space around the fire-box may be had, and the sides of

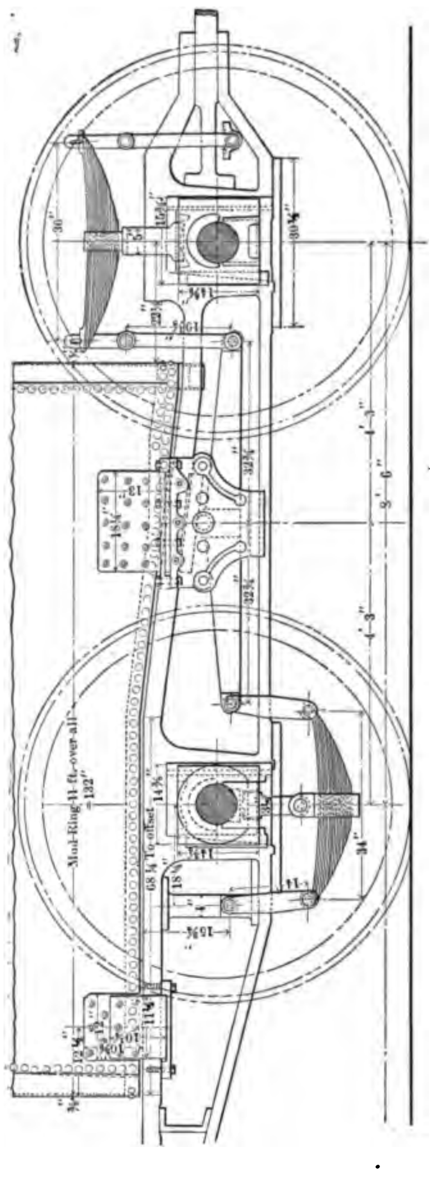
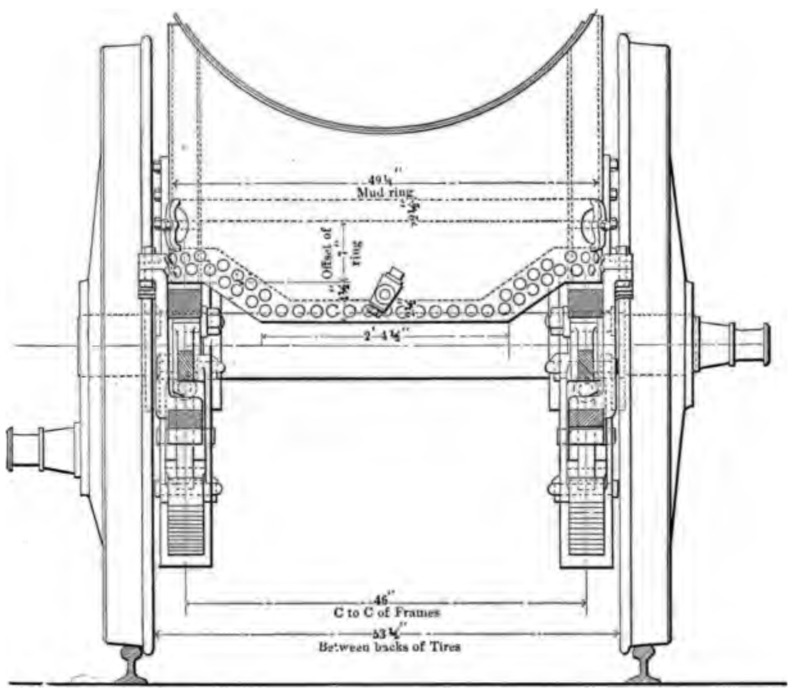


Fig. 7.

the furnace may be inclined sufficiently to take advantage not only of the greater efficiency of the heating surface, but giving the water a better chance to circulate. We also have more space for the ash-pan, and can hang it higher to keep it out of the snow and away from the driving boxes. The rigid wheel base can be shortened. It gives better clearance for eccentrics and straps. It makes a better proportioned boiler, when found necessary to increase the diameter of boiler shell or to lengthen the



Cross Section
(In front of Throat sheet.)
Fig. 8.

fire-box. The fireman can work his fire to better advantage, and the weight of engine can be more evenly distributed upon the wheels. The cost of keeping up the expansion braces is very much less, and the frames can be taken down and replaced at a very much less expense of time and money, than with the fur-

nace between the frames. Soft coal as well as anthracite is now being used in fire-boxes above the frames.

We present herewith an engraving, Fig. 9, showing manner of lapping sheets at corners of fire-box, as used on the Southern Pacific Railroad. Fig. 10 shows style of ash pan used on the Chicago, Burlington & Quincy Railroad, as preferred to that of Fig. 11, a free circulation of air being an essential requisite to keep the axle cool, and prevent the transmission of unnecessary heat to the driving boxes. Fig. 12 shows the fire-box of class H, Mogul engine, in which the distance from bottom of mud ring to bottom of lower row of tubes is 16 inches. Fig. 13 shows class D, consolidation, in which this distance is 22 inches; and Fig. 14 represents suburban class I, in which this distance is 24

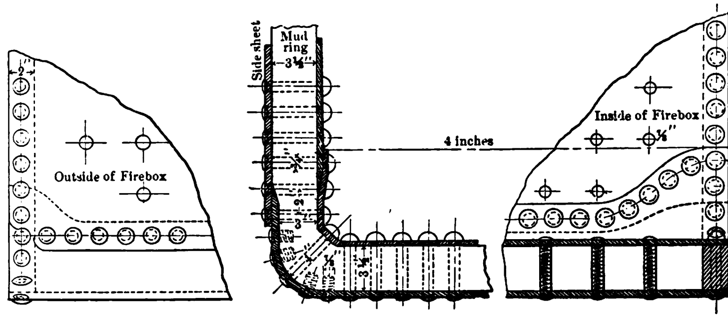


Fig. 9.

inches. The rest of these engravings will be readily understood. In classes D and H, the mud rings are level, while in class I, there is a straight incline toward the front end, having a drop of 7⅝ inches in a length of 6 feet. One reason for dropping the frame in this instance was on account of the short fire-box, so as not to cover the front of the grate with a pier to support the brick arch, and also to secure a good depth of fire between the grate and brick arch. In classes I and D, the tubes are 2 inches in diameter, while in class H they are 2¼ inches. This road uses brick arch with fire-boxes above the frames, and advocates its use generally in this style of boiler. In Figs. 15*a* and 15*b* are shown the brick arch referred to, which requires no further explanation.

We find through close observation that, on account of the peculiar formation of the boiler, owing to the curved sheets forming the front of the furnace, and the leg of the boiler, where the heat is most intense, the expansion and contraction of those sheets is necessarily greater at that location than at any other part of the boiler. Consequently, in a short time the sheets begin to work loose from the mud ring at the corners, more especially if the water be bad, and difficult leaks occur. With

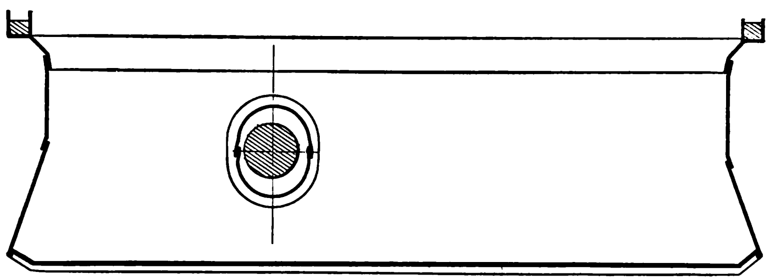


Fig. 10.

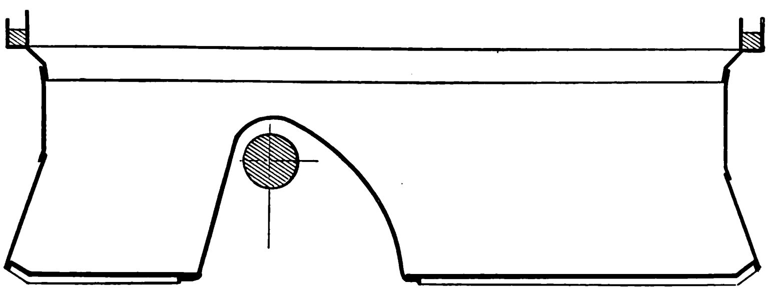


Fig. 11.

good water we find no such objection. We recommend double riveting at the corners at least, and that cast iron grates be used in preference to water bars. We like the brick arch and believe in its economy, but there are many practical objections to it. That, however, is a subject somewhat foreign to the one in hand, so we recommend that the Association discuss its merits independently. The disadvantages of placing the fire-box over the frames are, in our opinion, so small that we do not feel like tres-

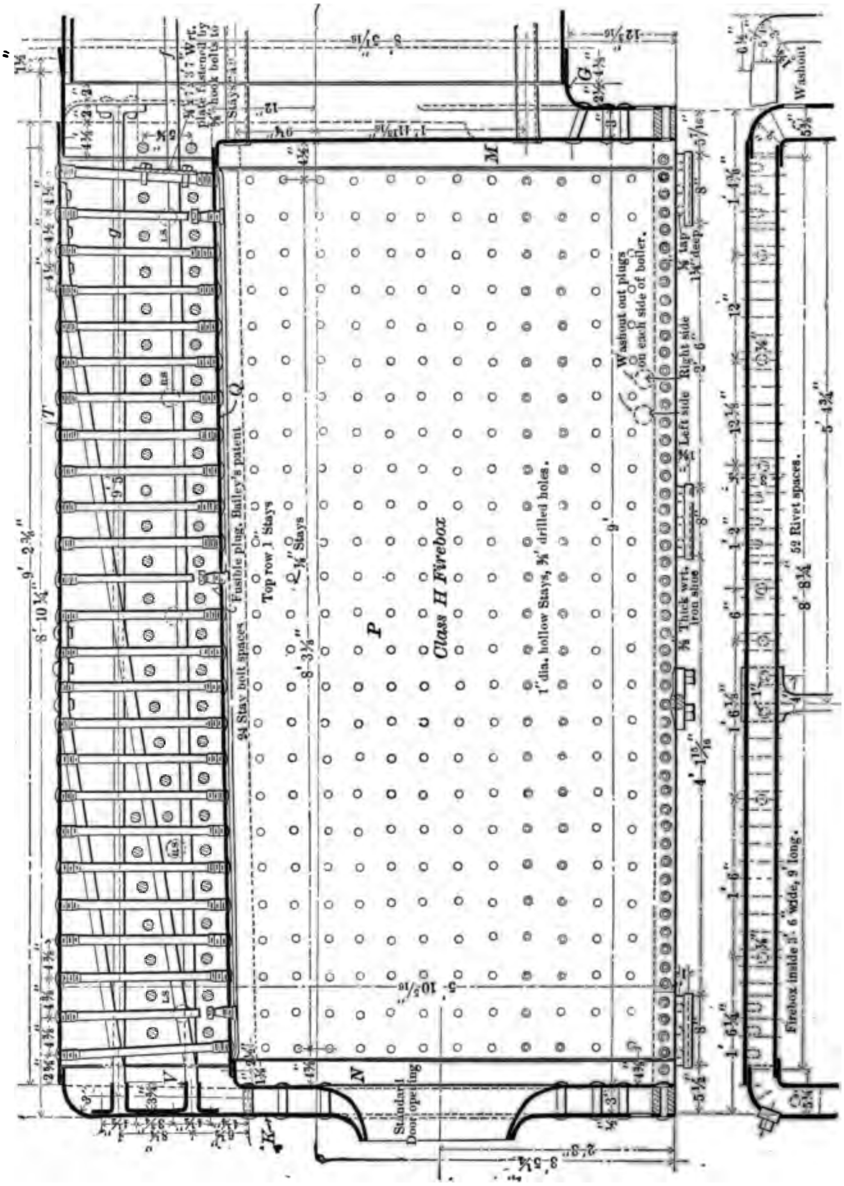

Class H Firebox
24 Stay bolt spaces
Fusible plug, Bailey's patent
Top row 1 Stays
1" dia. hollow Stays, 3/8" drilled holes.
Washout out plugs on each side of boiler.
Standard Door opening
Firebox inside 3' 6" wide, 9' long.
52 Rivet spaces.
Washout

Fig. 12.

passing upon your valuable time in attempting to discuss them.

From the meagre information received, and the entire absence of data relating to the actual performance of locomotives with fire boxes above the frames, and from the fact that the replies to our circular contain no comparisons of the relative economy between locomotives with the fire-box between the frames and those having the furnaces over the frames, your committee do not feel satisfied in this attempt to do the subject justice. Our report is therefore very incomplete. These replies have been very slow in coming in, so that after considering those communications, the time at the disposal of the committee was too limited to permit any experiments, which would have enabled us to determine certain supposed advantages of the wide fire-box. Furthermore, from information received from various builders of locomotives, there will probably be put to work within the next few months at least 300 to 400 locomotives with fire-boxes above the frames, from which reliable data can be taken. This should be done and embodied in a subsequent report. We suggest that this subject be continued, in order to permit of the collection of such data, and to make suitable experiments to decide the questions proposed.

FRED. B. GRIFFITH,
JAMES MACBETH,
W. A. FOSTER,
LEWIS F. LYNE.

Mr. Setchel moved that the report be received and the committee continued. The motion was carried.

Mr. Hickey moved that discussion on the subject lie over till next year's report is submitted. Motion carried.

Mr. George Gibbs resigned as a member of the Committee on Laboratories.

On motion of Mr. Mackenzie the vote on the continuing of this committee was reconsidered, and it was decided to discharge the old committee.

Next business taken up was the reading of the following report on

THE RELATIVE VALUE OF STEEL AND IRON AXLES.

Your Committee on the Relative Value of Steel and Iron Axles issued the following circular to members:

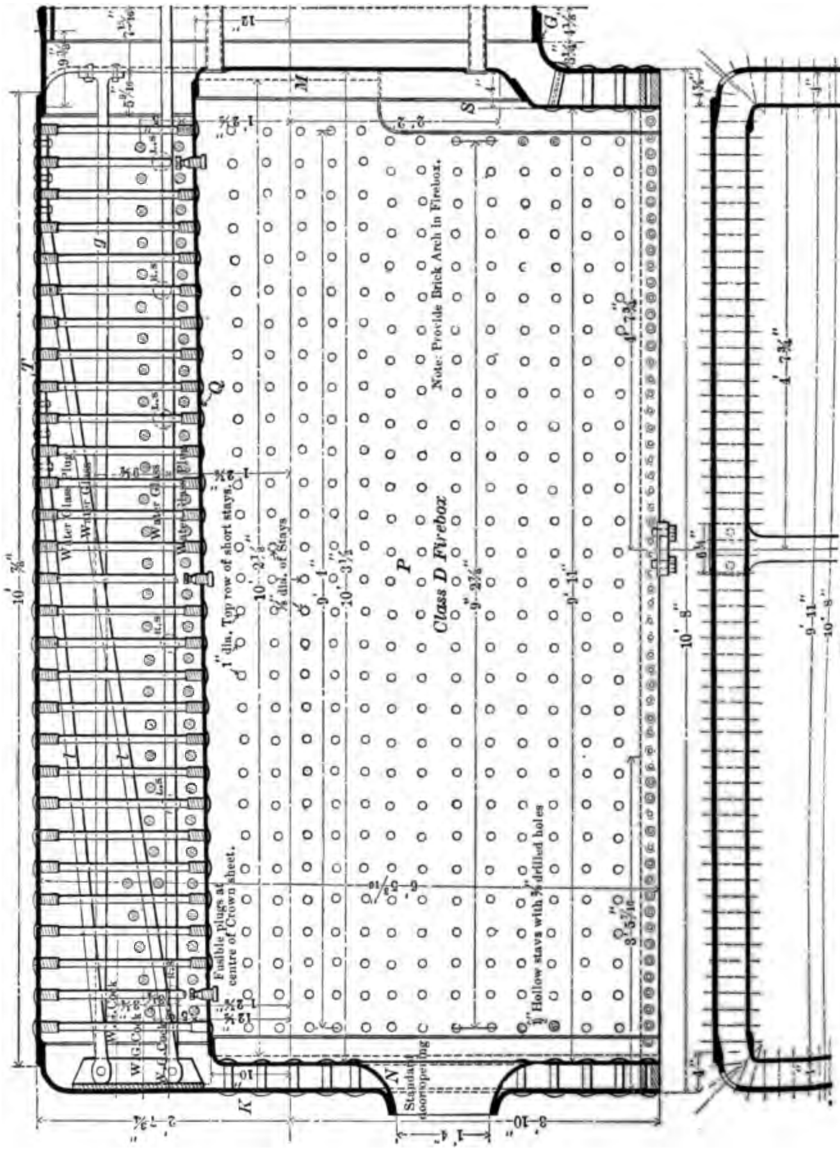

Class D Firebox
Note: Provide Brick Arch in Firebox.
Fusible plugs at centre of Crown sheet.
1" dia. Top row of short stays.
⅞ dia. of Stays
Hollow stays with ⅜ drilled holes
Standard door opening
Water Glass Plug
Water Glass
W.G.Cock
10'-⅞"
10'-8"
9'-11"
4'-7¾"
P
Q
T
M
S
K
N

Fig. 13.

1st. What in your opinion, would be the safe limit of diameter for driving axles?

	Weight per Journal.
Steel	12,000 16,000 20,000
Iron	12,000 16,000 20,000

For Engine truck axles.

	Weight per Journal.
Steel	5,000 8,000 11,000
Iron	5,000 8,000 11,000

For Tender and car axles.

	Capacity.
Steel	40,000 50,000 60,000
Iron	40,000 50,000 60,000

2d. Please give the relative wear of steel and iron axle journals per 50,000 miles run.

3d. Please give the relative wear of journal bearings on steel and iron axles per 50,000 miles.

4th. Have you had any steel axles break under locomotives or cars? If so, were they crucible, open hearth or Bessemer? Please give mileage to time of fracture.

5th. In your practice do you find steel driving axles to run any longer without turning than iron? Please give number of miles run between turnings.

Steel ....
Iron ....

The following information is taken from the replies:

Mr. Meehan, Cincinnati, New Orleans & Texas Pacific Railway:

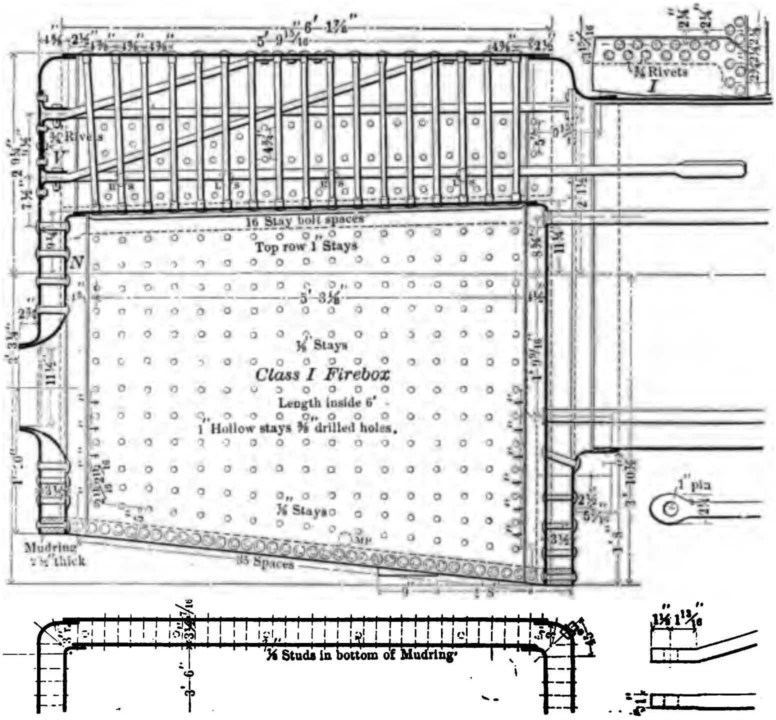

6'-1⅞"
5'-9 13/16"
¾ Rivets
I
V
N
16 Stay bolt spaces
Top row 1" Stays
5'-3⅛"
⅞" Stays
Class I Firebox
Length inside 6'
1" Hollow stays ⅜ drilled holes.
⅞ Stays
Mudring 2½" thick
35 Spaces
1" pin
⅞ Studs in bottom of Mudring
3'-6"

Fig. 14.

1st question. Has not had any experience with steel axles, but uses the following sizes of iron axles:

	Weight per Journal.	Diameter of Journal.
	12,000 lbs.	6¾ in.
Driving axle (iron)	16,000 "	7 "
	20,000 "	7¼ "
Engine truck axle (iron)	5,000 "	5 "
" " " "	8,000 "	5 "
" " " "	11,000 "	5 "
	Capacity.	
Tender and car axle (iron)	40,000 lbs.	3¾ in.
" " " "	50,000 "	4 "
" " " "	60,000 "	4¼ "

3d question. Does not make any record of wear of journal bearings.

Mr. McGrayel, Chicago, Rock Island and Pacific Railway.

1st question. Says number of steel axles in service are not sufficient to afford an opportunity to judge of their relative values. He recommends the following:

	Weight per Journal.	Diameter of Journal.
	12,000 lbs.	6¾ in.
Driving axle (steel)	16,000 "	7 "
	20,000 "	7¼ "
	12,000 "	7¼ "
Driving axle (iron)	16,000 "	7½ "
	20,000 "	8½ "
	5,000 "	4 "
Engine truck (steel)	8,000 "	4½ "
	11,000 "	4¾ "
	5,000 "	4¼ "
Engine truck (iron)	8,000 "	4¾ "
	11,000 "	5¼ "

2d question. No data.

3d question. No data.

4th question. Have had none to break.

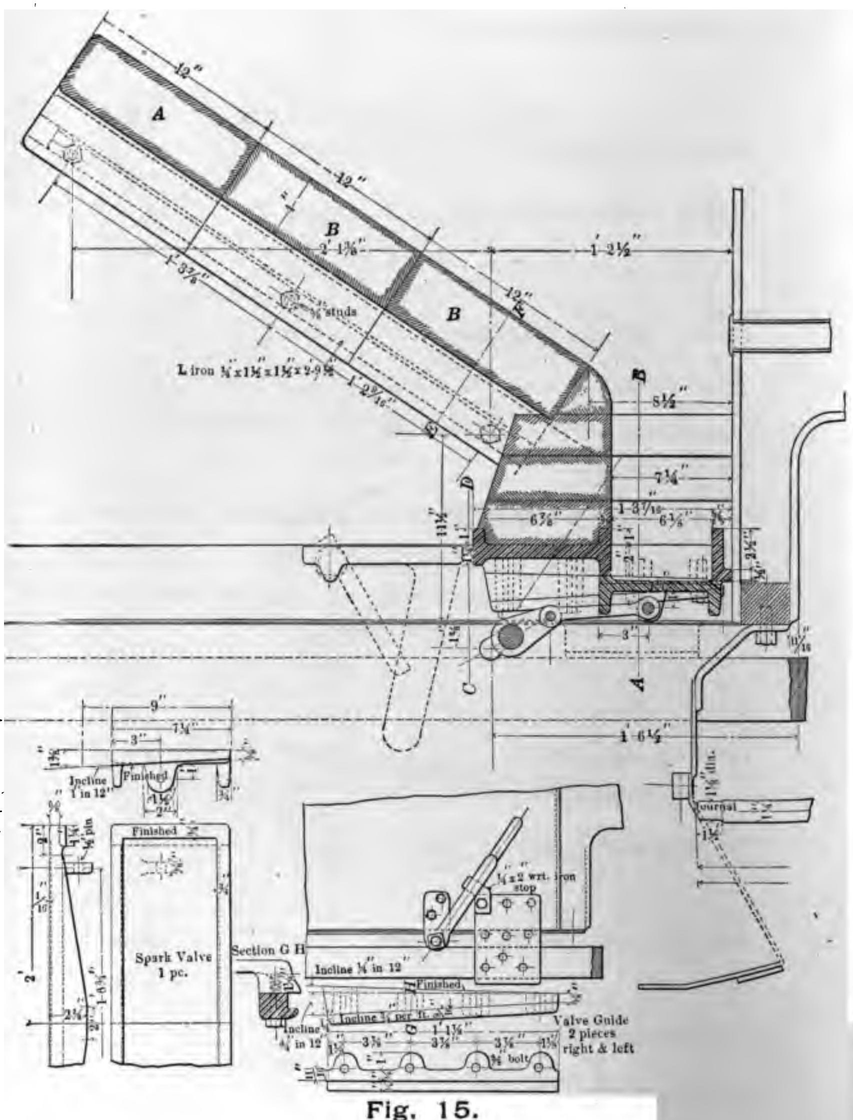

A
B
B
12"
12"
12"
2'-1⅝"
1'-2½"
1'-3⅞"
⅝" studs
L iron ¼"x1½"x1½"x2'-9½"
8½"
7¼"
6⅞"
6⅛"
3"
1'-6½"
9"
7¼"
Incline 1 in 12"
Finished
Spark Valve 1 pc.
Section G H
Incline ¼" in 12"
Finished
Valve Guide 2 pieces right & left
¾" bolt
¼ x 2 wrt. iron stop
Journal

Fig. 15.

Mr. Lacy R. Johnson, Canadian Pacific Railway.

4th question. Have never had steel axles break under locomotives, but have had two or three break under passenger cars. Gives no data as to cause of break.

5th question. Has not found it necessary to turn journals of steel axles, but has frequently done so on iron axles. Gives no data of wear.

Mr. N. W. Sample, Denver and Rio Grande Railroad.

1st question. Recommends:

	Weight per Journal.	Diameter of Journal.
Driving axle (steel)	12,000 lbs.	8 in.
Engine truck axle (steel)	5,000 "	5 "
	Capacity.	
Tender and car axle (steel)	60,000 lbs.	4¾ "

2d question. Has not had any experience with iron axles.
3d question. Has not had any experience with iron axles.
4th question. None.
5th question. Do not keep any records.

Mr. W. H. Lewis, Delaware, Lackawanna & Western Railroad.

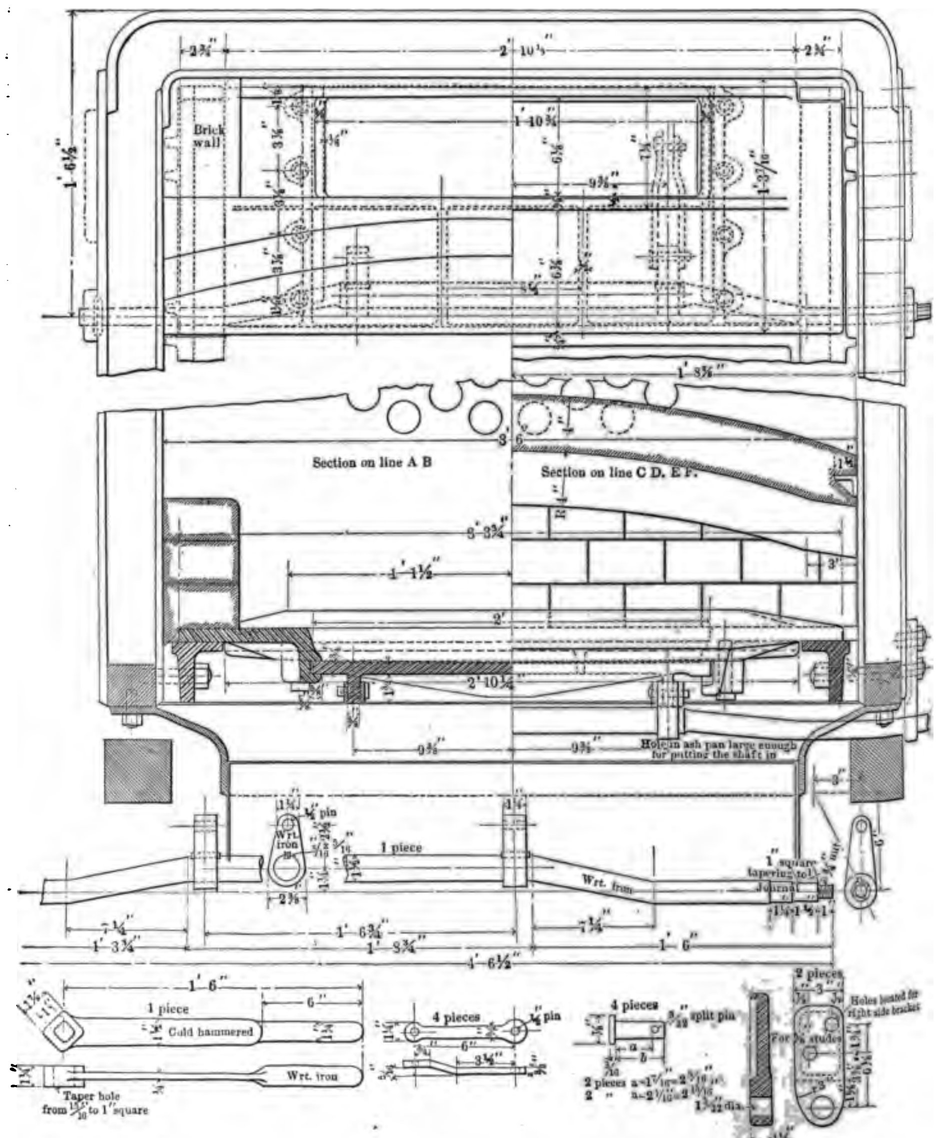
1st question. Recommends:

	Weight per Journal.	Diameter of Journal.
	12,000 lbs.	6½ in.
Driving axle (steel and iron)	16,000 "	7 "
	20,000 "	8 "
	5,000 "	4½ "
Engine truck axle (steel & iron)	8,000 "	5 "
	11,000 "	5½ "

Tender & car axles (steel & iron), M. C. B. standard, 3¾x7 in.

2d question. Has not had steel axles in use long enough to make comparison.

4th question. Has not had any steel axles broken except under an old engine, of which they have no record of service.



Brick wall
Section on line A B
Section on line C D. E F.
Hole in ash pan large enough for putting the shaft in
1 piece
Wrt. iron
1 square tapering to 1 Journal
1 piece
Cold hammered
Wrt. iron
Taper hole
4 pieces
4 pieces
split pin
2 pieces
Holes bored for right side bracket

Fig. 15a.

Mr. Graham, Delaware, Lackawanna & Western Railroad.

1st question. Recommends:

	Weight per Journal.	Diameter of Journal.
	12,000 lbs.	6 in.
Driving axle (steel and iron)	16,000 "	6½ "
	20,000 "	7 "
	5,000 "	4½ "
Engine truck axle (steel & iron)	8,000 "	5 "
	11,000 "	6 "
	Capacity.	
	40,000 lbs.	3¾ "
Tender and car axle (steel & iron)	50,000 "	3¾ "
	60,000 "	4 "

2d question. From observation, see no difference.

3d question. From observation, see no difference.

4th question. Has had some break. Open hearth. Cannot give mileage.

5th question. Steel will not run any longer.

Mr. G. A. Ferguson, Concord & Montreal Railroad.

Has not had experience with steel axles. Has no recommendations.

Mr. Wm. Swanston, Chicago, St. Louis & Pittsburg Railroad.

1st question. Recommends:

	Weight per Journal.	Diameter of Journal.
	12,000 lbs.	7 in.
Driving axles (steel and iron)	16,000 "	7½ "
	20,000 "	7½ "
	5,000 "	4¾ "
Engine truck axles (steel & iron)	8,000 "	5½ "
	11,000 "	5½ "
	Capacity.	
	40,000 lbs.	3½ "
Tender and car axles (steel & iron)	50,000 "	3½ "
	60,000 "	4 "

2d question. Does not keep any record of wear of journals, but has a record, one engine making 108,826, wear and turning reduced diameter $\frac{5}{16}$ in. This, however, is not an average, but a very bad case, and regards it as low mileage, even for an iron axle.

5th question. As a rule, steel axles do not require turning as often as iron.

Mr. Allen Cook, Chicago & Eastern Illinois Railroad.

1st question. Recommends:

	Weight on Journal.	Diameter of Journal.
	12,500 lbs.	7 in.
Driving axles (iron)	14,000 "	7 "
Engine truck axles (iron)	5,000 "	4 "
	Capacity.	
Tender and car axles (iron)	40,000 lbs.	3¾ "

2d question. The wear of iron journal, 7 in. diameter, under Mogul engine, is $\frac{1}{64}$ for 55,021 miles run.

Mr. W. J. Robertson, Central Vermont Railroad.

Has not had any experience with steel axles, and makes no reply to circular in detail.

Mr. T. J. Hatswell, Flint & Pere Marquette Railroad.

1st question. Recommends:

	Weight on Journal.	Diameter of Journal.
	12,000 lbs.	6½ in.
Driving axle (iron and steel)	16,000 "	7 "
	20,000 "	7½ "
	5,000 "	5 "
Engine truck axles (iron)	8,000 "	5½ "
	11,000 "	6 "
	Capacity.	
	40,000 lbs.	
Tender and car axles (iron)	50,000 "	4 "
	60,000 "	

2d question. No data.
3d question. About two pounds.
4th question. None have ever broken.
5th question. No. Steel 35,000 miles and iron 50,000 miles.

Mr. W. Augustus, Keokuk & Western Railroad.

1st question. Has not had sufficient experience with steel axles to give any information of value.

	Weight on Journal.	Diameter of Journal.
	11,000 lbs.	6 in.
Driving axle (iron)	13,000 "	6½ "

Engine truck axles (iron), limit of journal, 4¼ in.
Tender and car axles (iron), limit of journal M. C. B., 3¼ in.

Mr. F. J. Ferry, Louisville, St. Louis & Texas Railway.

Has not sufficient data to enable him to add to the report.

Mr. John Campbell, Lehigh Valley Railroad.

1st question. Recommends:

	Weight per Journal.	Diameter of Journal.
	12,000 lbs.	7 in.
Driving axles (iron and steel)	16,000 "	8 "
	20,000 "	9 "
	5,000 "	4½ "
Engine truck axles (iron & steel)	8,000 "	5 "
	11,000 "	5 "
	Capacity.	
	50,000 lbs.	4 "
Tender axles (iron and steel)	60,000 "	4 "

		Mileage per $\frac{1}{32}$ in.	Weight per Journal.
2d question.	Driving axle (steel), 4 years	171,366	15,000 lbs.
	Driving axle (iron)	272,877	9,000 "

3d question. Cannot give definite reply.
4th question. No breakage.
5th question. Do not turn driving axles. Remove them when worn so as to require turning. Mr. Campbell here says he is

using steel for all passenger locomotives; finds less trouble from heat, and therefore less lubricants are required. Recommends a limit for driving axles (iron or steel) to be regulated by the service.

Mr. Ross Kells, New York, Lake Erie & Western Railroad.

1st question. Recommends for safe limit:

	Weight per Journal.	Diameter of Journal.	
	12,000 lbs.	6¾ in.	
Driving axle (iron and steel).....	16,000 "	6¾ "	
	20,000 "	7¾ "	
		Pass.	Frt.
	5,000 "	4¾ in.	4⅝ in.
Engine truck axles (iron & steel).	8,000 "	4¾ "	4⅝ "
	11,000 "	5½ "	
	Capacity.		
	40,000 lbs.	3¼ in.	
Tender and car axle (iron & steel)	50,000 "	3½ "	
	60,000 "	3¾ "	

2d question. Records not complete.
3d question. Records not complete.
4th question. Have had no steel axles break.
5th question. Yes; depends on service.

Mr. G. W. Stevens, Lake Shore & Michigan Southern Railway.

Says: That it is the practice of this company (with locomotive equipment) to establish standard diameters of driving axles for engines of different weights per journal. From these a reduction is permitted of ¼, ⅜ and ½ inch before axles are condemned; the service of reduction being respectively passenger, freight and switching. With engine and tank truck, the practice is principally confined to one standard diameter, and permitted a reduction of ⅛ inch in passenger service. After this follows freight, with a reduction of ¼ inch, and then switching, with a reduction of ⅜ inch. With both classes of axles the plan con-

templates change from one class of service to another, and includes a mileage limit, which precludes further service after being reached, whatever may be the diameter. In other words, two limits are provided, one of size and one of miles, and whichever is first reached precludes the axles from further service in that respective class. The equipment entire is iron axles.

Mr. J. H. Murphy, New York, Lake Erie & Western Railroad.

1st question. My opinion of the safe limit (*i. e.*, the smallest diameter) for new axles is as follows:

	Weight per Journal.	Diameter of Journal.
	12,000 lbs.	7 in.
Driving axles (steel)	16,000 "	7½ "
	20,000 "	8 "
	12,000 "	7 "
Driving axles (iron)	16,000 "	7½ "
	20,000 "	8 "
	5,000 "	4½ "
Engine truck axles (steel)	8,000 "	5 "
	11,000 "	5½ "
	5,000 "	4½ "
Engine truck axles (iron)	8,000 "	5 "
	11,000 "	5½ "
	Capacity.	
	40,000 lbs.	3½ "
Tender and car axles (steel)	50,000 "	3¾ "
	60,000 "	4 "
	40,000 "	3½ "
Tender and car axles (iron)	50,000 "	3¾ "
	60,000 "	4 "

2d question. We have not been using steel axles for about one year, and I am not able to give any data as to the wear of steel axle journals for this reason. I give herewith, however, a statement of the wear of driving axles of one freight engine (No. 503, consolidation type) and one passenger engine (No. 74, 8-wheel

American type), thinking it may be of some use or interest. All of these axles were iron.

Journal.	Engine 503. Diam.	Diam.	Mile.	Diam.	Mile.
	$\frac{1}{7}$, 88	$\frac{11}{7}$, 88		$\frac{3}{6}$, 90	
Right, No. 1	$6\frac{13}{16}$	$6\frac{25}{16}$	This Eng.	$6\frac{11}{16}$	This Eng.
" " 2	$6\frac{25}{32}$	$6\frac{3}{4}$	made.	$6\frac{22}{32}$	made.
" " 3	$6\frac{11}{16}$	$6\frac{11}{16}$	22,220	$6\frac{21}{32}$	43,643
" " 4	$6\frac{23}{32}$	$6\frac{11}{16}$	miles.	$6\frac{5}{8}$	miles.
Left, " 1	$6\frac{25}{32}$	$6\frac{3}{4}$	$\frac{3}{7}$, 88	$6\frac{11}{16}$	$\frac{11}{7}$, 88
" " 2	$6\frac{7}{8}$	$6\frac{13}{16}$	to	$6\frac{23}{32}$	to
" " 3	$6\frac{3}{4}$	$6\frac{11}{16}$	$\frac{11}{7}$,88	$6\frac{5}{8}$	$\frac{3}{6}$, 90
" " 4	$6\frac{3}{4}$	$6\frac{23}{32}$		$6\frac{21}{32}$	

	$\frac{4}{9}$, 88	$\frac{3}{10}$, 89
Right, No. 1	$6\frac{3}{4}$, 88	$6\frac{3}{4}$, 89
" " 2	$6\frac{29}{32}$,	$6\frac{13}{16}$,
Left, " 1	$6\frac{26}{32}$,	$6\frac{3}{4}$,
" " 2	$6\frac{13}{16}$,	$6\frac{3}{4}$,

This engine made 45,082 miles in this time.

3d question. We have no record of the relative wear of journal bearings on steel or iron axles.

4th question. We have had no steel axles break since we put them in use, during past year.

5th question. Not having had steel axles in service a sufficient length of time, am unable to state from experience whether steel driving axles will run longer than iron axles without turning.

Mr. John Hickey, Milwaukee, Lake Shore & Western Railroad.

Says: In considering the diameter of a driving axle, we must be governed by the capacity of the cylinder, the boiler pressure and the diameter of the wheel, as well as the weight per journal. In other words, the diameter of driving axle should be proportioned to the power of the engine, like other parts of the machinery, and this being the case, it will be entirely safe for any customary weight. The diameter of the driving axle, therefore,

should be of such size and strength as to meet the power of the piston, rather than be simply to resist the weight brought upon it. As there is but little difference in the strength of the best quality of iron and a quality of mild steel suitable for axles, there should be little or no difference in their respective diameters when used under like conditions. For engine truck axles, my experience has been that the journals should be of such size as not to permit a greater load than three hundred pounds per square inch of bearing, and that the diameter of journal be not less than 55 per cent of its length. This rule will hold good for all bearings of railway rolling stock, except locomotive crank pins and driving axles, the size of which must be in keeping with the power of the locomotive. The wear of journals of course depends on the weight per unit of bearing in contact and the material of such bearing; a clear hard brass giving less wear for a given number of miles than softer metal. All other things being equal, we find but very little difference in the wear of steel and iron axles.

Mr. W. C. Ennis, New York, Susquehanna & Western Railroad.

Does not recommend any limit. His experience with steel, from 1872 to 1879, was very unsatisfactory, and they have abandoned the use of steel and use hammered iron. Is of the opinion that steel has very much improved, and therefore does not wish his experience placed against that of the present day.

Mr. John Mackenzie, New York, Chicago & St. Louis Railroad.

1st question.

	Weight per Journal.	Diameter of Journal. New.	Diameter of Journal. Safe limit.
	12,000 lbs.	7 in.	6¾ in.
Driving axles (iron and steel)	16,000 "	7½ "	7¼ "
	20,000 "	8 "	7¾ "
	5,000 "	5 "	4½ "
Engine truck axle (iron & steel)	8,000 "	5 "	4½ "
	11,000 "	5 "	4¾ "

	Capacity.	Safe limit.
	40,000 lbs.	$3\frac{1}{4}$ in.
Tender & car axle (iron & steel)	50,000 "	$3\frac{1}{2}$ "
	60,000 "	$3\frac{3}{4}$ "

2d question. Wear of four 5 in. steel engine truck journals: greatest wear, $\frac{3}{16}$ in. and least wear, $\frac{5}{64}$ in. to 118,043 miles run. Have not had any experience with steel driving axles. Iron driving axles of proper diameter make 50,000 miles per $\frac{1}{16}$ in. wear.

3d question. No data.

4th question. No breakage.

5th question. No experience.

Mr. T. W. Gentry, Richmond & Danville Railroad.

1st question.

	Weight per Journal.	Diameter of Journal.
	12,000 lbs.	7 in.
Driving axle (steel)	16,000 "	8 "
	20,000 "	$8\frac{1}{4}$ "
	5,000 "	$4\frac{5}{8}$ "
Engine truck axle (ham'd iron)	8,000 "	$4\frac{5}{8}$ "
	11,000 "	$5\frac{1}{4}$ "

Recommends $5\frac{3}{8}$ in. journal for over 8,000 lbs.

	40,000 lbs.	$3\frac{3}{4}$ in.
Tender and car axles (ham'd iron)	50,000 "	4 "
	60,000 "	$4\frac{1}{4}$ "

2d question. No data.

3d question. No data.

4th question. None.

5th question. Steel will run longer. Experience has been confined to driving axles of steel, as they use steel exclusively for such work. Has had excellent results from such practice. Did not get satisfactory results from smaller diameter journals.

From the reports received, your committee is unable to make any recommendations as to the value of steel as compared with iron. The members seem to have lost sight of the main question, *i. e.*. safe limit of diameter for driving axles, as called for by circular.

We therefore suggest that the whole matter be referred to another committee, and that that committee shall ask for new diameters of all new axles and for the weights as given in the circular; and also for the safe limit of diameter. The same to be given in the reduction of diameter, and also on the mileage basis. Steel and iron to be given separately.

JOHN MACKENZIE,
J. S. GRAHAM,
JOHN S. COOK.

On motion of Mr. Peck, the report was received.

DISCUSSION OF REPORT ON STEEL AND IRON AXLES.

SECRETARY SINCLAIR—In my travels around I have heard more interest expressed in the recommendations and investigations of the committee on this subject than on any other, with the exception of compound locomotives, and I am very sorry that our committee has not been able to collect sufficient data to make recommendations. There is one thing about steel and iron that is almost new at present. The price of steel is very little different from the price of iron. That is very different from what previously existed in this country when the prices of steel axles were generally about twice the cost of iron. There are many heads of machinery departments who are considering the practicability of using steel now when they never thought of doing it before. Consequently they want to receive information from those who have used steel as to the desirability of substituting that material for the iron now generally in use, and under the circumstances I think it would be desirable if the members present would express themselves as freely as possible on what their experience has been with the use of steel for all kinds of axles.

MR. GEO. GIBBS—Mr. Barr is the man who can talk about that. We have tried in the last two or three years some sets of steel car axles and the results have not been satisfactory. Our experience with crank pins, driving axles and car wheels is, that steel heats more and wears more rapidly, and does not have as good surface as iron. We therefore use iron in all cases. I do not know that we are quite up to date though in our trial of steel. It was made some years ago and great claims have been made as to improvements in the quality of steel since then.

In the use of steel there are other things to be taken into consideration beside the heating and the wear. One is the liability to fracture and the effect of low temperature on the metal. We all know that if steel is subjected to blows where there is a sharp shoulder or cornice, that fracture is liable to take place at those points where strains can concentrate. The matter of sharp fillets appears to be of as great importance in the use of steel as iron. From our present

standpoint, we are decidedly in favor of sticking to iron for axles and crank pins.

MR. WILLIAM SWANSTON—We are using steel entirely, and I think with considerably improved results. I cannot say there is very great improvement on the average mileage, yet there is to a certain extent an improvement—I think an improvement fully equal to the price. The price is very close, as the Secretary has just said, to that of iron. There is very little difference between iron and steel now, and I think we get a very much more uniform steel. We have none of those seams, and as a rule we run a little better. If you get a really good iron axle without seams there is but very little difference. But the homogeneousness of the steel makes a better journal. A driving axle has been quoted as an example. The axle was put in by my friend Reynolds here and ran 108,000 miles. It came on to our division and was reduced $\frac{5}{16}$ —$\frac{1}{16}$ beyond our limit. I took it out. The steel was good. There was no flaw. That, however, is an exception to the rule. I think you get a better mileage out of steel than you do out of iron. At the same time we have iron axles that have far exceeded the mileage of steal. But that is the exception.

MR. MCCRUM—Some eight or ten years ago, perhaps, I encountered the same trouble that a great many of our friends have encountered about getting a thoroughly solid iron and in view of that fact I determined to try some steel driving axles, and we have now some forty locomotives that are equipped with steel driving axles which were made some eight or ten years back when we were using a higher grade of steel than they use now. We were able to get a solid axle, but the wear of the journals was not satisfactory. I never noted any material difference in the tendency to heat as against the iron axle, but I did note a material difference in the wear. In the absence of any positive data, I would say that I believe we had as much as one-third more reduction in the size of the steel axle. That is we had at least a third more reduction I think in size over the iron, in engines of corresponding weight using the same material for bearing, and I never have used a steel axle that would burnish and polish under friction the same as a good wrought iron axle. My standard practice is, and I think will be to use the very best forged iron axle that I can get. It may be that in the matter of the milder forms of steel that we approximate nearer. There is one feature in connection with this that I think all mechanics appreciate or recognize—the necessity of avoiding the sharp angles in fittings. I make that a rule. I never use a square shoulder in anything where I can fit to fillet. I would say in this connection, that I never have had a steel driving axle break, neither have I ever had a wrought iron axle break, unless it was a case where it had been running longer than it should have run. But I am decidedly. from my experience, in favor of steel for axles.

I would just add, however, in that connection, referring to Mr. Gibb's statement with reference to using iron, that I never considered steel entirely satisfactory for crank pins. Consequently I commenced using iron crank pins case-hardened. It has been my practice for many years; but recently—within

the last six or seven years, I took up the subject of a mild steel for crank pins case-hardened, and I have met with what I consider better success in using the mild steel for crank pins case hardened than I ever did with iron pins. Then, I was somewhat in doubt for a time whether it was a wise thing to undertake to harden any kind of steel, but I was assured by some of the best authorities on that subject in the country, that there was no danger in doing so, and I commenced the practice, and I never have had a properly designed and properly proportioned mild steel casehardened pin break. I never have had a single one break and I believe that I can show results in crank pins that would really surprise a great many members of this Association. And during the time that I was in doubt as to whether it was a wise policy to continue the use of mild steel case-hardened, I had some 19x24 engines built by the Rogers Locomotive Works in which I specified Low Moor iron pins. Well, those engines have now been in service for two and a half to three years and out of that lot of engines I have had three of the Low Moor iron pins broken. Just before I left home we had one of those engines brought into the shop, and on one of the side-rod pins I found there had been a fracture that extended in about one-third the circumference of the pin and about half its length. The diameter of the pin was 4x4 inches and of course the brass or bushing rather, kept that piece in place and from the wearing or lamination of the two, the surfaces, where the fractured occurred, were perfectly smooth.

I had a test made of this low grade of steel to see what the change in the character of the steel would be by the hardening process. The section of steel that I had tested had a tensile strength of 57,250 pounds in its original condition and an elongation of 27 per cent. After being case hardened, it showed an increased additional strenght of 80,240 pounds and the reduction of elongation was the difference between 9 and 27 per cent—only 9 per cent. elongation after it was hardened. Now, the question as to whether that was a safer material after hardening than before is a matter that I do not care to undertake to settle. However, assuming that it is not the tensile strength that that pin has to endure so much as the bending strain, it would seem that the material after having been hardened was better adopted to that purpose than before.

On motion the convention adjourned for the day.

THIRD DAY.

The Convention was called to order at 9 A. M.

THE PRESIDENT—Gentlemen, the report of the Committee on Axles was read yesterday, but it has not been discussed. The subject is now open for discussion.

SECRETARY SINCLAIR—Before the regular order of business comes on, there are some Committees to be appointed. We want in the first place the appointment of a Committee on the place of meeting.

MR. MACKENRIE—In lieu of nominating that Committee I move that the Committee appointed to meet the Master Car Builders, be authorized to deal with that subject and report to the Executive Committee.

The motion was carried.

SECRETARY SINCLAIR—The next will be the report of the Committee on subjects.

The report of this Committee was submitted by Mr. Hickey, as follows:

SUBJECTS FOR INVESTIGATION.

1. Examination of engineers and firemen in their duties relating to the use of fuel, care of a locomotive, and ability to meet disorder or disability of machinery. To what extent practiced and best plan of conducting same.

2. Best type of locomotive for heavy passenger and fast freight service. Investigate the relative economy and safety of eight-wheel, ten-wheel and mogul engines for heavy passenger and fast freight service.

3. Washing locomotive boilers. Methods in use causing the least delay. Washing effect on plates of fire-box while retaining heat from the brick arch. Situation of washout plugs. Describe plan for washing out with hot water.

4. Locomotive rods, connecting and parallel. Suitable

material and best form of. Relative merits of solid ends, and those constructed with straps, bolts and keys.

5. Best material for locomotive crank pins, and proportions for same suitable for engines having cylinders 17, 18, 19 and 20 inches in diameter.

6. Office dials most convenient for showing condition, location, in what service, repairs required, etc., of all engines.

7. Comparative advantages of operating locomotives with different crews, on the first in and first out plan and that of confining the men to certain engines; the latter not running a greater number of miles than can be rendered by regular crews. Discuss any improvement in the method of running engines.

DISCUSSION ON SUBJECTS FOR NEXT YEAR.

MR. MACKENZIE—I move that the report of this Committee be received.

The motion was seconded.

MR. MACKENZIE—It seems to me that we are lumbering up the Convention every year with subjects, many of which receive no attention whatever, and in view of that fact, I think that the report of the Committee should be taken up as reported—each subject—or we might say, that the whole matter be referred to the Executive Committee which shall select from those subjects such matter as in their opinion is desirable to go before the Convention. You will notice that this year we have eleven different subjects and on many of them we have no report whatever. Now, you recognize the fact that up to the present time we have handled only four reports and here is the last day of our meeting and we have seven reports before us yet. We cannot get through with them, and, I move that it is the sense of this Convention that not more than six subjects shall be handled at any one annual session, and those subjects shall be handled either by instruction from the Convention or through the Executive Committee.

MR. PECK—I agree with Mr. Mackenzie. One subject that the Master Car Builders have gone into extensively the Master Mechanics have entirely overlooked. The Car Builders are going very extensively next year into the best material for brake shoes. I think the discussion of the last two days on mogul engines took in not only what should be the best material but the best form for mogul engine. I find I increase the mileage between turnings from 40 to 80 per cent. by using the Ross-Meehan shoe. I think where we have long wheel bases that that should be gone into. I think that that should be considered a very important subject. I put on cast-iron wheels where I have interlocking and safety switches, and I have the first derailment yet to come where I have had those shoes on, and I would like

to see that subject taken up in this next year as there could be some very important figures brought out on that line.

MR. HICKEY—I think to make six subjects the rule would not be a very wise proceeding. You may get six subjects that would not take perhaps one day. It should be dependent entirely on the character of the subjects. There are a great many subjects of which six would be more than enough, while with other subjects there could be eight or ten. I think that should be left to the Executive Committee. I would make that an amendment to Mr. Mackenzie's motion.

SECRETARY SINCLAIR—The practice has been to accept the report of the committee on subjects and act on that. In fact our Constitution requires us to do that. But the committee has put so many subjects on lately, that it is impracticable to deal with them and do any of them justice, and I think it would be a very good alteration to leave it to the Executive Committee to overlook and make changes in the list of subjects presented by the Committee on Subjects. That seems to me the most practicable way of dealing with it.

The amendment was carried.

MR. PECK—Now, Mr. President, I move that the subject of brake shoes be referred to the Executive Committee for consideration.

The motion was carried.

THE PRESIDENT—The regular order of business now is, gentlemen, the discussion on axles.

DISCUSSION OF REPORT ON STEEL AND IRON AXLES.

MR. MACKENZIE—I have but a few words to say on this matter, and inasmuch as the committee has been continued again I would like to call the attention of the members to the heading of the circular as it was issued last year, "We ask for the limit of wear," and when the circular goes out again, if I am continued on the committee, I would like to have every member bear in mind that we did not ask last year for the diameter of a new axle but we want the limit of wear—how much wear was it safe to run an axle—how much wear would you require before you would condemn an axle— a limit as to miles or weight, either. I think that the subject—the matter of iron and steel axles—can be very much broadened this time, and a great deal more information can be brought out than was brought out last time. I think we were a little lame ourselves. The committee did not cut the thing out in just the shape it ought to have done. There is no question in my mind but that everybody has some record more or less, but if you will look the report over, you will find none of them have got any. I know there is lots of information. Take for instance the Lake Shore Road. The superintendent of motive power there has a very thorough system of handling his wear of axles, tires etc., but he is very loath to give anything out. I do not see why anybody should have any fear of bringing anything here before the Convention.

There isn't any of us who is ashamed of anything he does, and it doesn't make any difference whether somebody else's views do not exactly coincide with what he thinks. I believe everybody should make such reports as in his opinion suits him best.

MR. SWANSTON—I move that the discussion on the subject be closed.

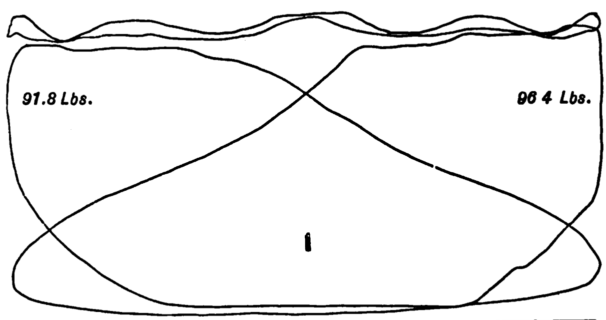
The motion was carried.

SECRETARY SINCLAIR—The next subject is the report on Exhaust Nozzles. Mr. Thomas will read the report.

Mr. Thomas read the report as follows:

EXHAUST PIPES, NOZZLES AND STEAM PASSAGES.

Your committee on the subject of steam pipes, passages and exhaust nozzles, beg leave to report that during the past two years the individual members of the committee have made a number of experiments with a view of finding some foundation



to start from on which to determine the size of exhaust nozzles in proportion to other parts of the engine or boiler.

The conditions that must be fulfilled by a successful and desirable nozzle are:

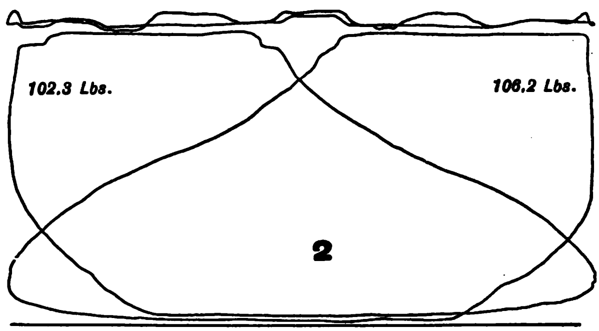
That it must create draft enough on the fire to make steam and at the same time impose the least possible amount of work on the pistons in the shape of back pressure.

It should be large enough to produce a nearly uniform blast without lifting or tearing the fire, and be economical in its use of fuel.

After two years of experiment and research your committee has come to the conclusion that owing to the great diversity in the relative proportions of the cylinders and boilers, together

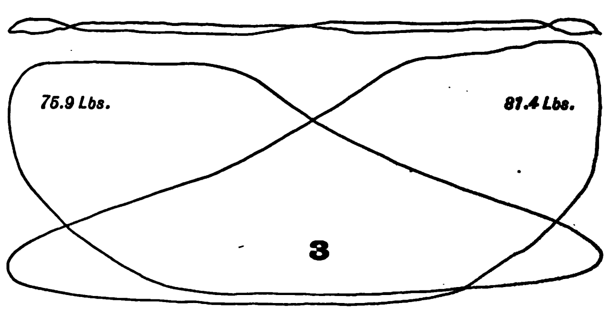
with the difference in the quality of fuel, that any rule which does not recognize each and all of these factors would be utterly worthless.

The quality of fuel is one of the most important factors, and must be recognized.



The diameter of the cylinder cannot be taken and the stroke and other proportions ignored.

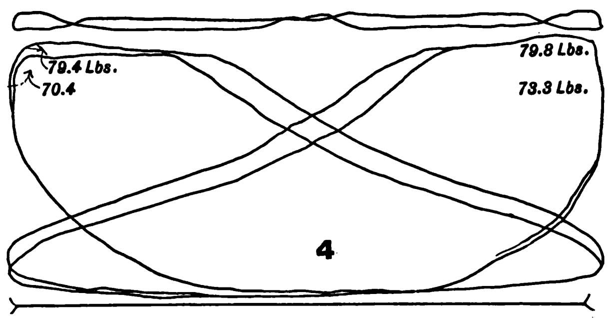
The size of stack alone, without taking into consideration the size of cylinder, grate and flue area is manifestly at fault.



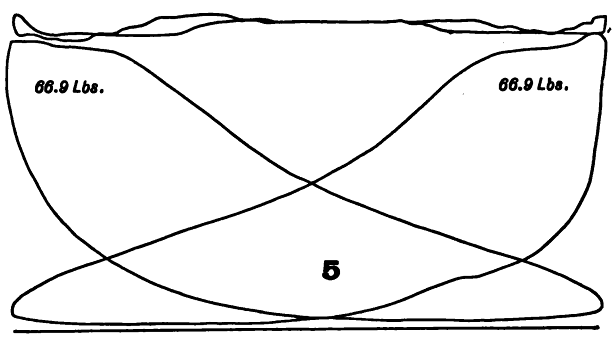
The principle question on which the exhaust nozzle practice of the country splits is whether the pipe shall be double or single.

Those using the double pipe claim that in this way only can the exhaust from one cylinder be prevented from adding injurious back pressure on the other, while the advocates of the single

nozzle urge that the use of the exits requires that neither of them shall be central and consequently the exhaust will not produce the maximum effect, while the single exit being in the axis of the stack will produce the maximum effect and can, in consequence, be made larger and reduce the necessary back pressure.



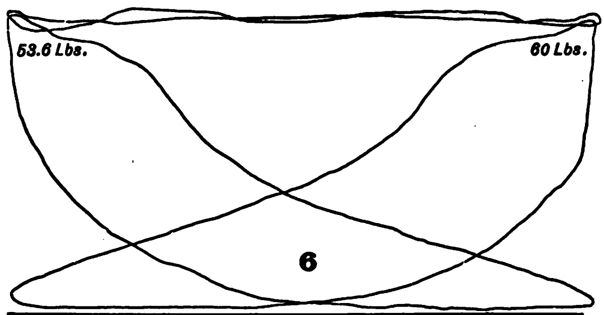
Your committee regard neither of these opinions as correct without some qualification. We have found that there is very little difference in the back pressure in either plan, and this is entirely a question of design. So true is this that it is impossible to determine, from the card alone, which type of nozzle is used.



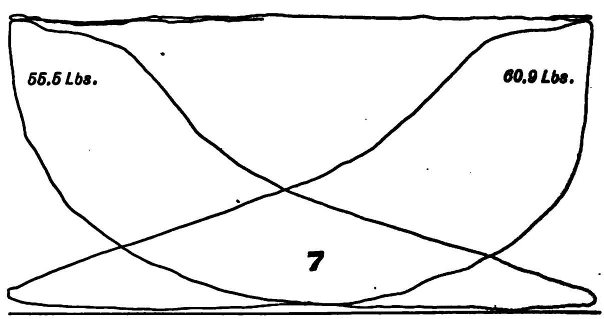
Your committee is also of the opinion that the use of the single exit does not insure concentricity of the exhaust steam with stack, and that in very many of the single pipes the steam is not discharged even approximately central.

The greatest part of the experimenting of the committee has

been with single pipes, with a view of embodying the results in future engines ordered by their roads. The questions which were to be determined were the total heights of pipes and the height of the bridge, relative to that of the pipe. Also the relation of the area of each exit at the meeting point to the final exit. The



first of these questions we have not determined. Starting with the idea that in order to reduce the effect of the exhaust of one cylinder upon the other, the bridge must be carried nearly to the top of pipe, we have found that the height had no perceptible effect in this direction, but the greater the height relative

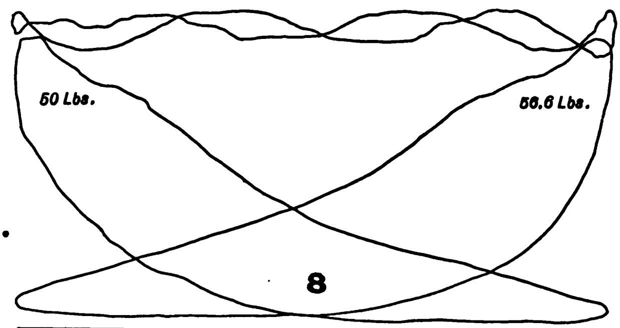


to that of the pipe, the greater was the difficulty in preventing the discharge from crossing in the stack.

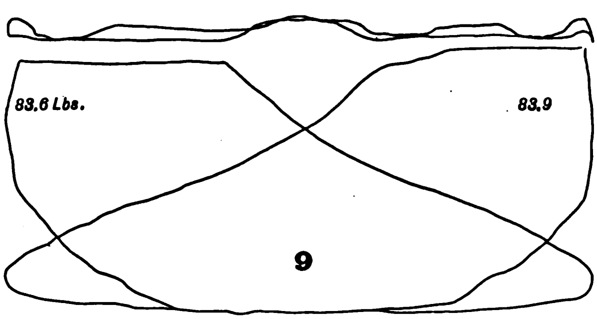
Acting on this, your committee has in some instances reduced the height of bridge to much less than half that of pipe, with no increase of back pressure. Your committee is of the opinion that the most vital point in the design is that the area of each

of the two pipes—where they combine—shall in no case exceed that of the final exit, and the indications, so far, are that this area can, with advantage, be made decidedly less than the final one, how much less we do not know.

Your committee, while aware that in addition to the types



of nozzle mentioned there are various annular ones as well as those in which the discharge is spread after leaving the pipe, but as yet we have not been able to test their merits as compared with plain pipes, except in the case of the Smith triple expansion pipe, on which experiments are now being made, and so far we



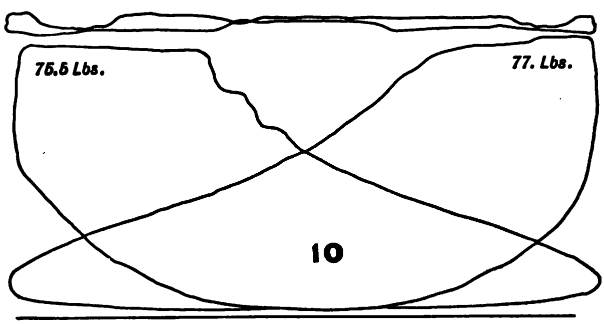
have found that the pipe allows the engines to steam freely with a very large final opening and we are in receipt of several communications from those using them in which considerable fuel economy is reported.

Your committee would also state that the use of a large final

exit relative to that of piston does not of itself imply low back pressure. They have more than once been misled by making this assumption without checking it by use of indicator.

Your committee submits drawing of one of the pipes which they consider has given good results, together with several cards from the engines using it. From these the members can judge how results compare with those obtained on their own roads.

In view of these facts, your committee feels itself incom-



petent to advise any plan to determine the size of exhaust nozzle in proportion to any other part of its engine or boiler believes that the best possible practice is for each user of locomotives to adopt a nozzle that will make steam freely and fill the other conditions named, best determined by an intelligent use of the indicator and a check on the fuel account.

C. F. THOMAS,
A. W. GIBBS,
JOHN HILL.

APPENDIX.

Mr. Thomas read the following letter:

"I wish to say I fully realize the difficulties encountered by the committee. Upon a recent trip through the Middle States I made a point to inquire of every Master Mechanic as to his practice in the matter of smoke stacks and exhaust pipes, and from the information so obtained it was impossible to form an opinion as to which of the many devices and the combinations of some were giving the best results. For what was reported as giving entire satisfaction upon one road would be found upon the scrap heap of another. Varying circumstances require alterations in the combinations, indicating the impossibility of laying down a hard and fast rule to suit all circumstances."

C. BLACKWELL.

DATA REGARDING INDICATING DIAGRAMS ILLUSTRATED.

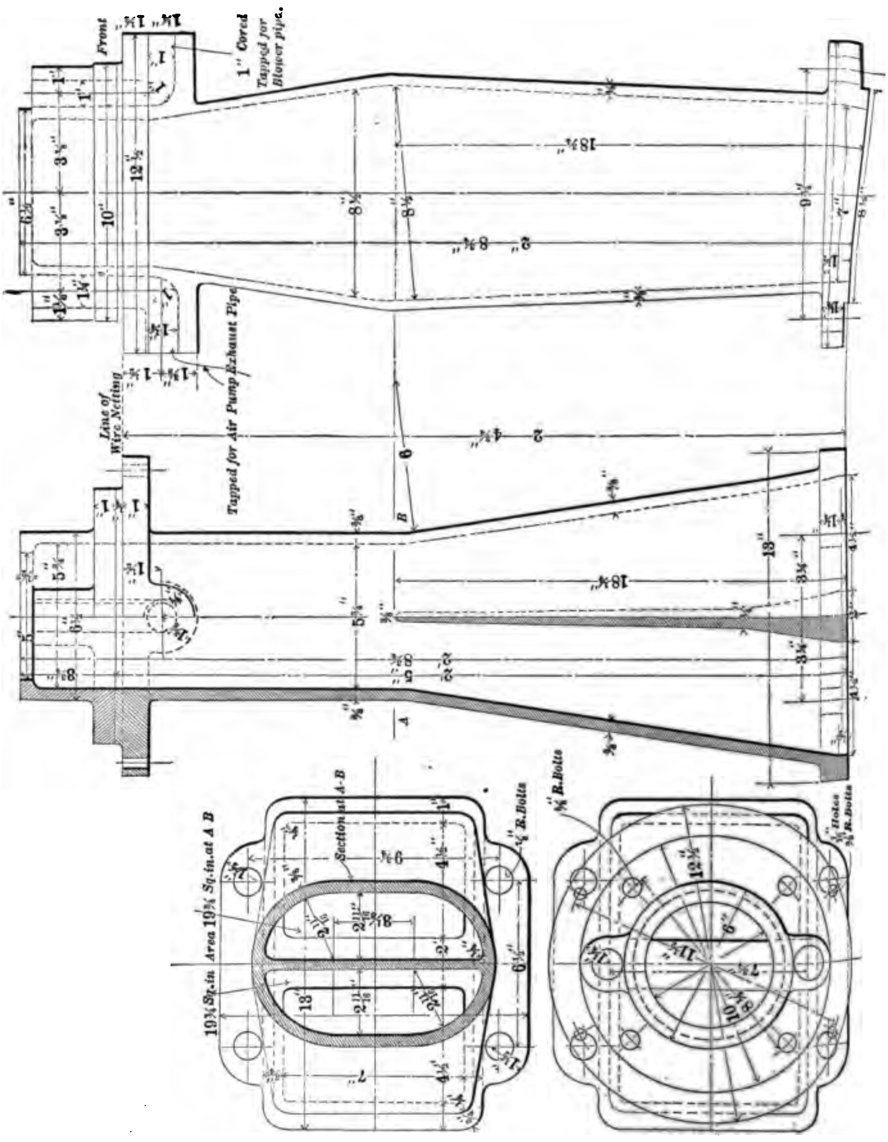
No. of Diagrams.	Boiler Pressure.	Revolutions per minute.	Mean effective Pressure.
1	160	142	94.1
2	165	102	104.2
3	160	182	78.6
4	155	174	79.6
5	165	192	66.9
6	160	202	56.8
7	165	164	58.2
8	160	248	53.3
9	160	170	83.7
10	160	154	76.2

The engine head cylinders 19x24 inches, exhaust nozzle, single, 5½ inches diameter. The train consisted of nine passenger cars, three being sleepers.

On motion the report was received.

DISCUSSION OF REPORT ON EXHAUST NOZZLES.

MR. GIBBS—I merely wish to explain why the Committee made a report without making special recommendations. The reason was that in looking at the subject we found men looking at it in two ways. One set of men were trying to get as uniform a blast as possible without regard to how the back pressure was produced. Another set were looking at the subject with a view to getting rid


Front
Cored
Tapped for Blower pipe.
Tapped for Air Pump Exhaust Pipe
Line of Wire Netting
Section at A-B
R.Bolts
Holes

of the steam as quickly as possible, so that the exhaust from one cylinder would not have any effect upon the other. The result is, we find, two very different patterns of pipes in use. In one form the steam is practically discharged into a receiver and then emerges. In this case there is a continuous exhaust prolonged from the time one cylinder exhausts until the other does. In the other case, where the areas are reduced, members have been looking more to getting rid of the steam as quickly as possible regardless of the question whether it produced or did not produce exhaust.

Another thing we have noticed, in changing from one part of the road to another where the coal varies, is that with some coals you can carry a very heavy fire to advantage, and in those cases the exhaust that produces the most pulsation produces the best results. On other roads, where the coal is different, it is necessary to use a very light fire. It is just such reasons as those that cause the excessive variation in practice that we find.

One other question that came in was that it was impossible to discuss the exhaust nozzle by itself ; that the variation in stacks and other portions made all the difference in the world, and it was impossible to formulate a rule without taking in all the conditions, and we found that we could not deal properly with so big a subject.

MR. L. S. RANDOLPH—I would like to ask the Committee if any attempt was made to gauge the vacuum in the smoke-box. It seems to me it would be exceedingly satisfactory if we could get the relation between the form of the smoke stack, especially in our straight stack, the size of the nozzle and its position to the amount of vacuum obtained. Of course that would have a certain effect, and be related in a certain way to the quality of the coal. But that is one of the points in the exhaust nozzle—to get the amount of vacuum. One of the points we want to get is the effect of the exhaust steam. We want to get that for the lowest amount of back pressure in the cylinder possible. I think there is no doubt about it, that the present practice in regard to the form and dimensions of the stack gives a very great difference—greater than there is any necessity for.

MR. ROBERTS—It seems to me that that is a matter that would be, as Mr. Gibbs says, impracticable to decide on account of the great variation there would be in the arrangement for draft even in front. The stack may work all right, but by different arrangements of diaphragms and draft pipes the nozzles and stacks would make considerable difference. It seems to me that the stack area, arrangement of diaphragms and draft appliances and exhaust nozzles would go together, and I do not see how we can arrive at any conclusion without taking in all of them.

MR. GEORGE GIBBS—I think we cannot begin to appreciate the difficulties that the Committee had to contend with until we look up this subject with the idea of formulating a hard and fast rule for the preparation of nozzles. It seems very simple in the start to try various forms to get one where you get the best vacuum under certain conditions. We made a great many experiments with that end in view in the beginning, and found that it was an insufficient

basis for drawing any conclusions from, for even our own practice, not to speak of a varied practice. The elements are very complicated, and the form of nozzles is only one. Smoke-box area, diameter of stack, nature of coal and grades and one hundred conditions come in there. The more you look into it the more complicated the problem becomes. For a particular class of engines we tested, we easily obtained the vacuums for different kinds of nozzles. We also determined for one particular nozzle that a certain vacuum produced a certain result. We found that more than a certain amount of vacuum would pull the fire through the flues, but we were totally unable from that to draw a conclusion as to the size of nozzle on the engine suited for slightly different conditions, and it seems to me the committee have done about as well as could be expected under the circumstances.

MR. RANDOLPH—I understood Mr. Gibbs to say that a certain vacuum would pull the fire through the flue. That is just what I would like to know about. Would Mr. Gibbs tell me about how many inches of water that would be? Was it measured in that way?

MR. GIBBS—Yes, we could easily give that for our engine, but I should have to give the dimensions of the engine throughout. We have 227 flues 2 inches in diameter and 11 feet long, and double nozzle exhaust pipe. We found that 8 inches of water pulled the fire through the flues badly and at 5 inches it was about good vacuum for a running position. From that it varied all the way up to 12 inches when the engineer was working his steam with long cut-offs and at too high speed for that period of cut-off.

MR. A. W. GIBBS—The committee has got some apparatus and is expecting to go a little farther into an arrangement by which they can take indicator cards from the smoke-box at the same time as they do from the cylinders. There seems to be no way of getting at the question excepting by indicating the smoke-box and the cylinders. If we get any information we will put it before the Association. We thought that by fitting an indicator on the smoke-box and one on the cylinders, and then making changes in the stacks and other parts, that we could possibly get cards which would show the effect of the exhaust, and we do not know of any other way we can get at it. Whether the apparatus is going to work or not is uncertain at present.

SECRETARY SINCLAIR—This has been a particularly modest committee. They have made a remarkably modest report, and I am afraid on the account of the modesty of the committee and the report that its value and importance may not be fully appreciated. Necessarily I have to pay a great deal of attention to the reports, and I think that this is one of the best of its kind that the Association has ever received. The report embodies a great deal of private investigation—of original research by the members of the committee. I feel certain that very few of the members of our committees have worked half so hard as those who have brought in this report, and the subject is very important. Although we have a very large number of subjects coming up, I think the Association ought to continue this subject, and let the committee be continued and enlarged if possible. This is a case where the enlargement of the

committee will do it a great deal of good, for if you put on more men who belong to roads where a special investigation of the subject has been going on they are liable to take more interest in the question than those who are merely written to and asked what they are doing. Therefore, I have pleasure in proposing that the subject be continued and the same committee be enlarged.

The motion was carried.

THE PRESIDENT—The next in order is the report of the committee on Brick Arches in Locomotive Fire-Boxes.

Mr. J. Davis Barnett read this report:

BRICK ARCHES IN LOCOMOTIVE FIRE-BOXES.

Report of committee on "Brick arches in locomotive fire-boxes. Their efficiency in consuming the various gases composing black smoke. Saving of fuel when used in connection with extension front, and as compared with diamond stack. First cost and cost of maintenance."

Your committee respectfully submit the following:

A circular was addressed to the members of our Association calling for information on the subject of brick arches, to which thirty-one replies were received, showing that twenty-four used the arch, fourteen of whom used circulating pipes, and ten used studs, angle iron, or a combination of both to support it, and seven did not use the brick arch in any form; three of the latter used anthracite coal for fuel, one used wood, one had tried the arch and discarded it—no reason given; the remaining two had never used it.

Your committee find it is the unanimous opinion of all those who use bituminous coal and brick arch, that it is most efficient in consuming the various gases composing black smoke, and by impeding and delaying their passage through the tubes, and mingling and subjecting them to the heat of the furnace, greatly lessens the volume ejected and intensifies combustion, and does not in the least check but rather augments draught, with the consequent saving of fuel and increased steaming capacity that might be expected from such results. This particularly when used in connection with extension front.

The statements of several experienced members based upon actual tests, extending through long periods, also show most conclusively that the brick arch may be used with short front

and diamond stack, with excellent results and great ecocomy, when bituminous coal is used as fuel, while but very few replies to our circular give positive data, from which even an average per cent. of the saving of fuel could be shown. There remains no room for doubt as to the economy of a properly arranged brick arch in a locomotive fire-box, using bituminous coal as fuel. Some of the replies say the saving is from twenty-five to forty per cent. This assertion is backed by the unanimous opinions of all those using them. The same can be said of its efficiency in decreasing the number of live sparks thrown from stack.

Your committee have positive proof that the claims for fire along many roads, which formerly used no arch, have been greatly lessened by the use of the arch, even without the extension front, and, when used in connection with the extension front, the throwing of dangerous live sparks was almost entirely avoided, as long as everything was kept in good shape. In addition to the great advantage already mentioned, your committee ascertained the fact beyond dispute that the arch in connection with a well arranged extension front greatly lessens the throwing of fine cinders and dirt from the stack on the train, thus prolonging the life of car roofs, varnish, paint, etc. Especially is this apparent on passenger trains, and of course adds greatly to the comfort of the passengers.

Your committee fail to find in the large correspondence they have held with practical men who are using the arch, any evidence that one well constructed and properly applied has any seriously damaging effect on the sheets of the fire-box or boiler tubes, but on the contrary much evidence is shown that the tubes are greatly protected at fire-box end, and do not cut away or clog up as fast as when no arch is used, and that as a rule when an arch has to be removed to clean out or work upon flues that were in good shape when the arch was applied, that the arch will be found to be nearly burned out and to have been in place a reasonably long time, and probably saved many times the cost of its removal and renewing.

The average brick arch supported on circulating pipes costs about $30 in place in the fire-box, in some cases more, in others

less; the cost varying with the mode of application, number and thickness of tubing, etc. The addition of extension fronts averages about $100. The item of stack and cast front end proper, with door, are not included in cost of arch and extension as given here, as these would have to be used under any circumstances. Your committee find that the arch complete on circulating pipes is applied on some roads for from $17 to $20, while others who are equally as well equipped to do the work say it costs them from $35 to $45. We also find the same difference in cost of applying extension front in various shops; some roads claiming to apply it for $60, while others say it costs them $150 not including stack and front proper and door. We find the greatest difference in cost of applying arch exists on roads using devices other than circulating pipes to support arch. One road puts in arch complete for $4, another for $5, while some using almost the same arrangement place the cost for complete arch at $20.

The information gathered by your committee shows conclusively that the first cost of arch, supported on circulating pipes in a safe and substantial manner, is about twice that of most of those supported by angle irons, protected studs, etc., and if we can be safely guided by the written statements of some of our most intelligent and practical master mechanics, these latter devices, if properly protected by allowing the bricks to cover the supports, last longer than the best applications of the former, and of course the danger attending the bursting of a pipe is dispensed with. Your committee find it very difficult to decide from any data furnished them by members of the Association, or from any other source, "The best manner of supporting the arch." Those using circulating pipes claim it as best, and say they have in most cases tried other plans and gone back to the pipes. Others who formerly used pipes have abandoned them for angle iron, and still others with studs protected by a pipe drill to shield them, and the whole somewhat covered by the brick arch.

There are many points in favor of abandoning the circulating pipes if other satisfactory supports can be arranged. First, The circulating pipe support is attended with more danger from their liability to become clogged or burning thin and bursting,

or from blowing out of sheets and scalding firemen or others, even where rigid inspection is made at regular periods. Second, The pipes are more costly to apply and difficult to adjust to position, and in order to secure a safe and tight fit, great care must be taken in cutting and tapping holes and threading pipe, sleeve, nut, etc., and in the few instances where arch pipes are put in and expanded in position, thinner tubes must be used and very large holes bored in sheets opposite ends of tubes, all of which are somewhat objectionable. Third, The pipes are generally more or less in the way of working on boiler tubes, particularly where more than three pipes are used, and if only three pipes are used, broken bricks cannot be utilized, which is one of the best features of the pipe support.

The good points of the pipe support must not be overlooked, however, and among them may be mentioned, First, As a rule, a simpler and consequently cheaper style of brick can be used. Second, If four pipes are used, nearly all broken bricks can be utilized, and to those familiar with the shipment of car load lots of ordinary arch bricks, this is a big item. Third, If, as claimed by many, that the bricks injure the side sheets when allowed to rest close and hard against it, as is generally the case in most other methods of supporting it, the pipes will admit of a suitable space being left at ends of bricks without impairing the rigidity of their support. Fourth, When shops are well equipped and have good system, the circulating pipe support can be put in for much less than it is costing most of our roads at present.

Your committee find that the first cost of applying brick arch and extension front to new locomotives while building, can be done in the best manner for about $130 over cost of short front, diamond stack and plain fire-box, and possibly for less than this, while it will cost about the same money to convert an old short front and plain fire-box into brick arch, extension front and straight stack; but as the old engine should have some credit for difference in cost of diamond stack, if in fair order, as compared with cheap straight stack (a good cast-iron stack of latter type can be made and fitted to smoke-box and bolted in place with saddle complete for $14), it can be done for less than $130 per engine, if properly handled.

Your committee find it is the almost unanimous experience of all those using the brick arch and extension front, that its cost of maintenance is much less than the cost of keeping fire tight and spark proof any form of diamond stack, or other stack, or spark arrester, with cone and netting and lining exposed directly to the action of coal sparks driven by exhaust, the cutting effect of which is almost as severe as the "sand blast," and causes constant and frequent renewals to all exposed parts, while the compartively gentle suction of the high nozzle of the extension is ample to clear the tubes and deposit the sparks in the front, but does not cut away the heavy steel wire netting below the nozzles. The sparks in the one instance are caught and driven before the exhaust steam and along with it, while in the other they are sucked or pulled after the successive exhausts, and the sand blast effect is destroyed.

The data gathered by your committee fail to show any comparative figures of cost of maintaining the two styles of fronts, but the evidence is overwhelmingly in favor of the brick arch and extension front (outside of first cost), and there seems to be no doubt on the part of nearly every one using the arch and extension, that after an engine has been properly equipped with both, they can be kept much nearer fire tight at a greatly reduced cost over the diamond stack and short front; in fact, where the extension is properly applied and kept absolutely air tight below the the line of spark accumulation, and a proper adjustment of baffle plates, netting, etc., made and kept, and sparks regularly blown out, they frequently ran from one tire turning to another without any cost of renewing parts, and in many cases instances are shown where plates, nettings and other parts are run in constant service for several years, and where cast iron stack is used it only has to be renewed in case of accident.

Your committee desire to call attention to the exhaustive report on "Extension fronts and brick, and other fire-box arches," to be found in report of our Convention of 1888, pages 35 to 61 inclusive, of which Mr. John Hickey was chairman, and which so fully covers the subject, especially the efficiency and economy of

the brick arch and extension front, in connection with bituminous coal fuel.

In conclusion, your committee find that the brick arch greatly assists in bringing about more perfect combustion, and thus aids in lessening the amount of black smoke formed, and for the reasons already set forth, helps to consume or rather burn out the combustible parts of the gases composing the smoke that is formed, and failing to find that any serious damage results from their use, and that the first cost and cost of maintenance, as compared with ordinary "diamond" stack, plain fire-box and short front, is plainly in favor of the former. We therefore recommend its use by all who desire to get the best and most economical results from bituminous coal fuel.

We recommend as the "Best manner of supporting the arch" that arrangement embodying as its principal features—First, Freedom from any danger to those constantly employed about the engine by failure of parts, such as are sometimes attended by the use of circulating pipes. Second, One that can be quickly and cheaply, yet substantially put up and maintained, and that is in a measure protected by the arch from the action of the fire. Third, One that will allow the bricks to be removed and replaced with greatest ease, and least possible damage, and that will give easy access to the boiler tubes, tube sheet and crown sheet when bricks are removed, and we think that these several conditions are nearer met by some of the methods shown on blue prints on exhibition in the meeting room, and known as the "Angle iron and stud supports," and we believe that the best features of some of these might be combined and worked into a support that will meet the requirements of the general service. We are not prepared to recommend the abolition of the circulating pipe, but we suggest the serious consideration of a safer and cheaper method for supporting brick arches than is obtained by their use.

Before closing this report we desire to call attention to the large number of arch bricks broken in transit and by handling after they are received. This is especially the case where bricks are hauled long distances and when shapes are flat, long and heavy. It has occurred to us that some suitable means might

be adopted to strengthen the brick by having iron rods made up in the moulds in such manner that should the bricks become cracked or broken through their section, they would be held together and could be utilized, and as soon as exposed to heat in furnace, they would fuse together from the effect of accumulated slag, etc.

T. W. GENTRY,
ALLEN COOKE,
L. C. NOBLE,
W. A. SMITH. } *Committee.*

On motion the report was received.

DISCUSSION OF REPORT ON BRICK ARCHES.

MR. SETCHEL—To my mind this is of far greater importance and capable of producing a greater saving than the compound engine. I think that any man who has ever used the brick arch would say that there is not less than 25 per cent. saving, and some get a great deal higher than that, and the cost is about 10 per cent, of what it would take to make a compound engine. In this report the committee have done themselves great credit, and I move that a vote of thanks be returned to the committee.

The motion was carried.

MR. MCCRUM—I would further move that a vote of thanks be tendered to the Committee on Exhaust Pipes, Nozzies, etc.

The motion was carried.

MR. HICKEY—I find here on page 3, the Committee says: "There are many points in favor of abandoning the circulating pipes if other satisfactory supports can be arranged. First, the circulating pipe support is attended with more danger from their liability to become clogged or burning thin and bursting or from blowing out of sheets."

I would like to ask the members of the committee or any gentleman present, if they ever had any experience with those circulating pipes being clogged or bursting or doing any injury. We have had them in use for more than five years now. We use a special brand of pipe for the purpose, 11 inch wire-gauge. It is 2 inches outside, the same size as the flue, so that we can caulk it and handle it as we would a flue; the inside diameter being smaller on account of the increased thickness of gauge.

THE PRESIDENT—I think Mr. Lewis can tell us of some pipes that were plugged up pretty badly on the New York, Chicago & St. Louis.

MR. W. H. LEWIS—Yes, Mr. Chairman, we had a number of engines, when I was connected with that road, where the brick arches were supported on tubes running from the flue-sheet to the back-sheet in the fire-box, and the water on the third division of the road was very bad, and notwithstanding the

fact that we used a great deal of care in removing the plugs that were opposite the ends of those pipes and ran the rod through there every time that we washed the boiler, they would stuff up, and the tendency was to draw out of the sheet and loosen themselves in the sheet, and we had no success with the circulating pipes there.

MR. McCRUM—I, like Mr. Hickey, am very anxious to get an expression from this Convention on the question of the best method of supporting brick arches. My practice at present is to use the tubes; the tube extended into each sheet, into the flue-sheet and into the back fire-door sheet, with a wash plug opposite the tubes and those are removed every time the boiler is washed out. We have only been using arches supported on tubes in this way for about a year and a half. So far we have not had any flues clogged up nor any noticable clogging in washing out, but when we first commenced to use those tubes we used a No. 12 tube and we had some trouble in their giving out in the bend, where they were thinned by the process of bending and stretching, and we have adopted a heavier tube now. We are using at present a No. 11. Whether or not that will obviate that difficulty remains to be seen. I think the impression is there will be no objection in using as heavy as a No. 10 tube, which can be readily expanded as you all know with an ordinary expander, and our practice is simply to make a nice fit of the tube in the sheet allowing the tubes to project through as far into the water space at each end as it can be expanded with an ordinary expander say 3/8 to 1/2 inch; being careful to get the distance as equal as possible. Where tubes have been put in like that we never have had any difficulty in their leaking in the joints to speak of, any more than any ordinary boiler tube. I have often put them in without using the copper ferrules on the end, but those who have used the copper ferrules the same as is the common practice in setting tubes on the fire-box end, seem to think that it makes a better job. Mr. Briggs, I believe, has been putting them in in that way and perhaps might give some information as to the relative value of the two methods of setting the tube. In that connection we have had the impression that perhaps a little larger than the 2-inch tube might be preferable. We adopted the 2-inch to start with, because it was a common size, and something we always had and that we could use our ordinary expanders with. But I think, especially for long fire-boxes, perhaps a slightly larger tube, say 2 1/4 or 2 1/2 inches perhaps (some roads I know are using 3 inch tubes) would be better. Now, it seems to me, that taking it all in all, the principle of supporting arches on tubes has some advantages over any other plan I have known. In the first place you can use a straight brick which costs something less than an arched brick, and they are readily and easily applied. It is true that I think there will be an objection to putting in more than three pipes in an ordinary width of fire-box. The main objection that I see to that would be that the spaces between the tubes would be too close to enable a man to go into the furnace to work on the tubes, which we find when any work on flues has to be done to amount to anything, because the arch has got to be taken out. I have had some singu-

lar experiences in reference to engines with brick arches. While I recognize they are a valuable thing, unquestionably so, and while I am not prepared to say how much fuel is saved by the use of the arch, I do not think as much, as Mr. Setchel said, is saved but I do believe it would be fair and consistent for us to claim perhaps 10 per cent. While I have no data to establish anything in reference to the matter, I believe that 10 per cent. or more, perhaps, is a fair assumption. Generally speaking, I think there is much less tendency for the tubes to stop up. I think the life of the tubes is longer by using the arch than a plain box. But in two or three instances I have had a great deal of trouble with the flues stopping up and clinkering on the fire-box end in engines using the arch, and I have undertaken to determine the cause of that and so far I have been unable to arrive at any conclusion. Out of twenty-five or thirty engines that I have equipped with the brick arches supported on tubes in the last year, I have had two or three instances of this kind in which I have had more trouble with the flues coating over and stopping up than I did before—I think more than I ever did have with the same engines or engines of the same class without the arch, using the same stack and size of nozzle and all.

MR. SETCHEL—I always like to have some foundation for my faith, and as there is a gentleman here who has kept data which show an exact saving, I would like to call upon him for some figures—Mr. Meehan, of the Queen & Crescent.

MR. MEEHAN—We have been using the brick arch for a little over eight years. We use No. 4 wire gauge in pipes. We made a thorough test when we commenced to use the brick arch and extension and we found positively that we had 30 per cent. saving. We used three classes of coal on the road, and we found the same results with the three classes of coal. We found a little difficulty at the commencement with pipes bursting, but it was on account of their getting too old. The pipes, as a rule, when they got to be about eighteen months to two years old would burst at the bend. They would wear out at the bend from sparks from the fire. As soon as I found that out, we numbered the pipes, commencing at the right side and numbering them 1, 2, 3, 4. There is a record kept of the pipes and they are taken out every eighteen months. With this arrangement we have no trouble with the bursting of the pipes. I am sure there is not any gentleman in the Convention who has paid any attention to the brick arch, who cannot get on the hind end of a train and count every shovelful of coal that the fireman has put in if the fire is maintained properly. Coming up the other day on the Chesapeake & Ohio Road, I was standing on the hind end, and I found that the engine was equipped with a brick arch. While I thought he was exceeding the amount of fuel he should put in, I could from the hind part of the train count distinctly every shovelful of fuel that the fireman put in. In addition to that it is the greatest educator in the world for a fireman. A fireman with the old method of firing is not liable to pay particular attention to his fire, but with a brick arch he is compelled to. He sees by putting in a certain amount of fuel that he gets better combustion, that it

is an easier matter for him to get an incandescent fire and maintain it incandescent, and consequently he never puts in too much fuel. If he has any habit of observation at all you will have no trouble in educating him. All things considered, I do not think any man running a railroad can afford to get along without the brick arch and extension. We tried the extension before we commenced the brick arch, and found it was a great nuisance, that it was a very difficult matter to prevent the extension from getting hot with the slightest particle of leak. The extension would also get full of sparks.

When we equipped our engines with a first-class brick arch, it lessened the flow of sparks and we had no difficulty in keeping up the standard. So I came to the conclusion several years ago that one is necessary for the other. If the extension is put up properly in the first place, you will have no trouble with it. With the extensions that have been running for five years and stacks that haven't been touched, the wire netting is as good as the day it was put in, although my impression is that netting is hardly necessary. The spark that is taken from the fire-box is lifted from the fire-box. The inertia carries it over the focus of the vacuum and into the extension, and nothing goes out but what is light enought to be caught on the focus of the vacuum and carried up the stack. I found by taking the netting out completely and stripping everything except the diaphragm and making the diaphragm a little lower than it would be with the netting, we get equally good results with regard to sparks; that is, provided the arch is properly maintained and not further front than 16 inches.

MR. GRIGGS—The statements that Mr. Meehan has made I am sure are right. I used the arch and experimented for the last thirty-four years, and I will agree with what Mr. Meehan has said in regard to the saving of fuel. I can show statements which have been tested time and time again with and without the arch on the same train, same car—mileage and everything.

MR. MCCRUM—Since Mr. Meehan has named the fact of 30 per cent. saving in the arch, I am better enabled to reconcile a certain thing that I have done recently as perhaps being more attributable to the arch than any other one thing. I recently made a change in an engine that had a diamond stack. The engine was a 16½ inch cylinder. It was an old engine and not a very modern type, consequently not a very free steamer, although the engine was running with a diamond stack and with 2⅞ double exhaust nozzles, and I took the engine into the shop recently and made the following changes: I took out a set of grates that had an opening of $\frac{11}{16}$ between the fingers, and put in a coarse grate with 1 inch between the fingers. I put in a brick arch where she had the plain box before; took out the flues and cleaned them; they were somewhat encrusted. I put on what might be called an ordinary plain front end. However, the front end was just 4 inches longer than the one that was taken off, by making the front 36 inches from the flue-sheet to the front door. I used the diaphragm and nozzle with a coarse netting, that is a netting of No. 2½ wire. The engine's record on fuel for two months

prior to the time I left home as against her previous year's record, run by the same engineer and fired by the same fireman, is just 43 ⅔ per cent. saving.

MR. HATSWELL—I would like to ask Mr. McCrum. if there was any other work done on that engine.

MR. MCCRUM—The engine had a general overhauling, but prior to the time of coming into the shop her valves and packing were perfectly tight. We took the flues out and cleaned them and put them back again. I concede there is no doubt of some saving in the matter of a clean boiler against one not cleaned.

MR. HATSWELL—I cannot make that saving on our road. We can make a general average saving of 10 or 15 per cent. on fuel. We started in, using pipes of No. 4 gauge. We now use a 2 inch flue, No. 12 gauge. Now, we have a little trouble with the mud accumulating over our door. First we put them in the crown-sheet and there we were troubled with mud accumulating, and now we have the same trouble over our furnace doors. I would like to ask if the other members who are using the extended front are troubled the same way.

MR. O. STEWART—As to the use of the circulating pipes to support the brick arch, the point that our committee makes is, I think, a point well taken. It is a dangerous thing. I do not think we have any right to put anything in our boilers that is dangerous to engineers or firemen, especially as to my mind there is no necessity for using it. On the road with which I am connected, we have used the brick arch for at least twenty years, and have never had a circulating pipe of any kind. We take a piece of 3 by ¾ flat iron and draw the end down so that we can get a ¾ thread on it. Make a T-headed bolt and screw it into the side of the box and rest the arch on that. We do not even let the head of the bolt into the brick. We set it on top of this lug with a screw into the side of the box. We have no trouble with it at all. The heads of these bolts will last four, five or six years before they will burn off.

MR. GENTRY—Mr. Hickey asked the committee if they had any personal experience with pipes bursting. I would like to state for the benefit of Mr. Hickey and the Association that I have had such experience, and that we have had quite a number of such experiences, and we have had pipes burst many times in service and narrowly escape scalding the firemen fatally. About a year ago we had one where it was difficult to tell whether the pipe burst from some defect or was burnt out. I rather think it was from a defective pipe, because the boiler was comparatively new. In that particular instance the fireman was killed. That happened on the 10th, of May last year, and we have been very seriously considering, on my particular division, some other means of supporting the arch. We use almost the same plan Mr. Meehan uses. We have never used a thin pipe. We may be mistaken there; we may be using a pipe that is too thick. We are using a pipe two inches on its outside diameter—a number 4 wire gauge, or what we know as extra hydraulic wire tubing. We may be using a pipe that is too thick. Our

experience with a thick pipe is anything but very satisfactory. We find them burning out now very frequently and we do not know of any means by which inspection will cover that dangerous point. We have a man who goes in and examines them. We keep the age as well as we can. We let the pipe run only about eighteen months. If one pipe has shown a defect and the application of all was made at the same time, we take them all out. We have a blue print here of the arrangement we use. It has a narrow nut, however. While we have no blackboard or any place to hang our prints, there are some very interesting ones here—probably more than we have ever been able to get together before. There are several ways there of supporting a pipe and I believe all the methods of supporting it on the studs. We have several plans similar to that explained by Mr. Stewart of the Fitchburg road. I was agreeably struck by the facts we were able to get together showing the life of those supports. I find they last longer than our pipes do, frequently. I take it as a whole that the committee thought it proper to call attention to this element of danger—that there is an element of danger when the arch is supported on the pipes, and a large majority of the members seemed to express the opinion that there is a dangerous element in the pipe support.

MR. HATSWELL—I wanted to ask if it was considered any more dangerous for the engineer and fireman with a circulating pipe bursting than it is with an ordinary flue bursting.

MR. GENTRY—I do not know that it is; but we find it very difficult to get any arrangement for dispensing with the tubes or flues, but we believe we can support the brick arch by some other means.

MR. HATSWELL—Sometimes the circulating tubes burst, but we never have had a fireman or engineer injured with the circulating tubes bursting. Last summer we had an engineer laid up three months from a flue bursting, but we never had one injured by a circulating tube bursting. We can determine the length of life of a circulating tube. We almost always find that our circulating tubes give out right after the boiler is washed out. The only way we account for that is that in washing out the boiler the scale is loosened and the circulation in the tube is clogged. In using 160 pounds of steam we use a 12 wire gauge tube and we do not have any of those tubes bend on ordinary work. When they come out they show a clogging in the bend. We do not consider there is any more danger with a circulating tube bursting than with a flue.

MR. D. L. BARNES—This matter of economy of the brick arch has been the subject of investigation elsewhere—and very scientific investigation. On the Paris, Lyons & Mediterranean Railway in France, the superintendent of motive power, Mr. Henri, has devoted a great deal of attention to the matter for the purpose of determining the best conditions into which a simple locomotive could be put, and to that end he had constructed a locomotive boiler in which the barrel could be lengthened or shortened by means of rings. In the boiler the tubes could be shortened to 9 feet and lengthened to 23 feet. In the fire-box he placed three kinds of arches, a long fire-brick arch, a short fire-brick

arch and a water arch. That boiler was put in a separate building and surrounded with every known piece of apparatus for measuring. The conclusions with reference to that point are very short. I would say further that the conclusions he drew from the experiments, which were long-continued, as to the value of the different lengths of tubes in connection with different kinds of arches, included also the value of the different amounts of vacuum measured in inches of water.

With regard simply to the arches and the evaporation per hour, they state first, that the long arch always diminishes the evaporation per hour, but diminishes it less when the tubes are long. The short arch diminishes evaporation per hour for the long tubes and increases it for the short tubes. The water arch affects the total evaporation per hour in a manner similar to that of the short brick arch, but more energetically. With regard to the economical operation of the boiler with reference to the brick arch only, the long arch increases economy most when the tubes are short and when the vacuum is greater. The short arch operates in the same direction but in a less degree. The water arch produces substantially the same effect as the long arch, with ordinary vacuums of $1\frac{77}{100}$ inches, and for medium length of tubes the short increases economy 6 per cent., the long arch and the water arch about 8 per cent., the improved arches 9 and 12 per cent. for short tubes of $10\frac{8}{10}$ feet.

I will say further, this improvement is above that evaporation or economy of a boiler which is well fired such as these boilers should be when fired always by the same man in a separate building where no interruption is possible.

Mr. Hickey—Speaking of the circulating tubes on which the brick-arch is held, I think that is very important in connection with the brick arch. In considering the thickness of the tubes it may be well not to lose sight of the fact that the tube may be too thick for safety. The fact of getting so much metal in the tubes has two bad features in my mind; it reduces the internal area of the pipe and perhaps clogs to some extent a good, free circulation. In the second place you get a pipe so thick, that has so much metal that expands and contracts so much that it is injured at the point of contact with the sheet. To my mind, while I have not made experiments as to the thickness most suitable, a No. 10 or 11 wire gauge would be much safer and perhaps more desirable and more useful than one having a greater thickness.

Mr. Meehan—I want to set myself right on the fire-box question. We get different results from the different classes of fire-box. We do not get as good results from a shallow fire-box as from a deep fire-box. I tried a No. 11 wire gauge tube; but I found when the thread was cut, it made it very weak at the end of the nut, and they broke off on several occasions at that point, and I found it absolutely necessary to put in No. 4 wire gauge, and although Mr. Hickey states that he is getting good results from No. 11, you can readily see that you cannot afford to use a No. 11 wire gauge and use a nut.

Mr. McCrum—I would like to ask why the expanding of the tube is not a a reliable method of fastening—why not as reliable as our method of expanding our boiler tubes?

Mr. Swanston—How do you expand the ends on the crown sheet?

Mr. McCrum—I do not put them into the crown sheet; I carry them into the fire-door sheet.

Mr. Hickey—Seeing that our time is short, I move that the discussion of this subject be now closed.

The motion was carried.

The President—The next in order, gentlemen, is No. 8—"The Best Means and the Economy of Preserving Locomotive Tanks from Corrosion."

Secretary Sinclair read the report on the subject.

TO PREVENT CORROSION OF WATER TANKS.

St. Albans, Vt., May 13, 1890.

Your committee would report that under the above heading circulars were issued with the following questions:

(*a*) What is the best means and the economy of preserving locomotive tanks from corrosion?

(*b*) Have you, in repairing tanks, used any method or device to prevent the corrosion usually observed on top sheets, and those sheets forming a coal pit? If so, please inform your committee of the same, and the additional cost incurred in securing the best results; and if of a metallic or other form of preventative, please send sketch or blue print of same.

(*c*) If members know of any means of preventing water tank corrosion not referred to in this circular, they are requested to send particulars.

We have received replies from forty-eight members, mostly representing the large trunk lines of this country, and a majority of opinions expressed therein demonstrate that from one to three heavy coats of some mineral paint, or coal tar, put on the surfaces usually exposed to the corrosion acts as a preventative. Other methods of prevention have been used on different roads, and are worthy of consideration and adoption under some circumstances. In order that this convention can get the full benefit of the replies, your committee deem it advisable to give such replies entire.

Mr. T. W. Gentry, of the Richmond and Danville Railroad, writes:

"We have given the matter much thought, but am sorry to say we have as yet been unable to decide upon any cheap and reliable remedy. We have been enabled to greatly lessen the

corrosion of our tanks where constantly exposed to the action of coal, by keeping them scraped clean and regularly coated with very thick iron clad paint. In order to do this frequently and systematically, we have a rule, which is rigidly enforced, requiring engine crews to take only enough coal on their in-bound trips to reach shops and have enough to fire up. This not only compels them to move all coal from top of tanks, but also exposes the sides and back of 'coal pit,' which is then scraped and painted, if at all corroded since last painting. We find that it is the coal that is allowed to accumulate and remain for long periods against the surfaces that does the mischief.

"We tried to shield our coal pit with a wooden lining, but it was a failure; fine coal dust would get through and be acted upon by water and other causes, and as it prevented scraping and painting the surfaces, it rather accelerated corrosion. The same may be said of iron shields, unless they be made as a part of the tender, which would mean nothing less than double thickness, as it would be difficult to get them tight enough to prevent dust and water getting between surfaces.

"The idea of making those parts of our tanks that are constantly exposed to coal out of sheet copper of suitable thickness has occurred to us, thinking that, where a standard tank was built, the copper parts might probably wear out several steel or iron portions, and as the parts to be made of copper are less liable to damage by accident, it might pay us to do so; but we have never put the idea into shape to get any data as to cost, and I only mention it as pertaining to the subject.

"As to the 'best means of preserving locomotive tanks from corrosion,' I am unable to say, and simply give my views and experience for the consideration of others, and add our practice as being the most feasible and economical, as well as efficient, that has come under our observation. As to the 'economy of preserving them,' there is no doubt in my mind that money can be saved each year by arresting decay in tanks, both inside and out, by preventing corrosion."

Mr. J. H. Small, of the Southern Pacific, writes that, in addition to coats of mineral paint given the tops of tanks, sufficient slope toward the coal pit should be given for drainage.

A reply from Mr. Godfrey W. Rhodes and Mr. Wm. Forsyth, of the C., B. and Q. Railroad Company, reads as follows:

"We think the most important thing in preventing corrosion is to provide good drainage for all portions of the tank—at the top, sides and bottom—so that water mixed with sulphurous coal is not allowed to stand any length of time against the sheets. For this reason we make a space of one-half inch between the floor boards, and are careful to use no moulding around the rivets at the bottom of the water leg and outside sheet. We believe it is a common practice not to paint the inside of tanks, but think it would be an improvement if some paint could be obtained which would protect these sheets from rust, and would at the same time not be affected by hot and cold water.

"In reply to your second question. In our later construction we have made the top plates incline about four inches on the sides, and also a portion of the back top plates. The flat portion at the back of the man-hole in this tank, and in our older tanks with flat tops, we expect to drain with a two-inch pipe extending through both top and bottom of the tank. The inclined sheets add very little to the cost.

"We have not used any method to prevent the corrosion at the back portion of the coal pit, though we think it quite desirable to find some satisfactory method of protecting this portion of the tank."

Mr. James Meehan, of the C., N. O. & T. P. Railroad, writes as follows, accompanied by blue print 1986:

"We cut the flare from the rear part of the tank about six inches in front of the water hole, and run a flare across the tank in front, leaving the rear part of the tank with nothing but the hand railing, similar to the enclosed sketch.

"While the flare was around the tank, and in rear of the water hole, the water was caught on the top sheet, and passed through the fuel, causing the coal to freeze in cold weather and the tenoning of the tank frame to rot very rapidly, as well as corroding the tank.

"We find the above plan to be very good, and is all that we have done to prevent corrosion."

Mr. James M. Boon, of the West Shore Railway, gives it as

his opinion that the best way to prevent these sheets from corroding would be to have them galvanized. He is unable to give cost of process, as it has been quite a while since he had any so treated. Some time ago, when in the employ of another road, he built a number of new tanks, the sheets of which, forming the coal pit and top of tanks, were galvanized steel. He watched them closely, and while he remained on the road they fully came up to his expectation. He does not now remember what the additional cost was, but thinks it very moderate. Neither is he able to say what the final outcome of the experiment was.

Mr. E. B. Wall, of the Pennsylvania lines west of Pittsburg, sends the following, in addition to blue prints of the standard tender and tank:

"The flooring of tenders should be of yellow pine, thoroughly saturated in fernoline, with three-quarter inch spaces between planks. We have found that oak floors help corrosion, as it contains an acid which we have found very severe. The flooring in the coal space should not be elevated above the rest, but a quarter inch plate of steel or iron should be used, and a space allowed between the edge of plate and sides of coal space. This is to facilitate getting rid of all water that may at any time get into the coal space or come in contact with coal space sheets. The moulding around the bottom of tank on the outside should not be used, as it prevents the escape of water. To prevent the corrosion of top of sheets in the tanks, would suggest that on each side of the tank an overflow pipe be placed, so as to allow any water that may accumulate in the top sheets to run off."

Mr. H. Schlacks, of the Illinois Central, sends blue print showing method of arranging water or man-hole on back of tank for engines used in suburban service, which consists of a cast iron elbow riveted to back of tank, and states that this method prevents to a large extent the trouble of corrosion.

Mr. C. W. Rickard, Division Master Mechanic of the Nitrate Railway Company, located in Chili, South America, writes that for inside of water tank, with water containing several corrosive ingredients, a wash of pure Roman cement, put on the same as whitewash, is used by him with good results.

Your committee have looked into this matter of corrosion

very thoroughly. The time has been too limited to make any special experiments, but we are of the opinion that, from the information received from the various Master Mechanics of this country of their methods and experience thus far, the same would indicate that several coats of a superior metallic paint, allowed to become thoroughly dry and hardened before the tank is put to use, would prevent a great deal of this corrosion. The idea of sloping the top sheets of tank toward the centre of coal pit undoubtedly prevents the standing of water on those sheets; but, in this practice, the fact remains that the moistened coal mixing with the cinders from smoke stack will cause a certain amount of corrosion on tanks so constructed. At the same time this is a move in the right direction, and is a benefit. One member of this Association suggests for the side sheets of coal pit to be constructed of corrugated brass sheets, the corrugation to stiffen the sheets, making it possible to use a lighter gauge. The idea is considered good, but the first cost to railroads would possibly cause an objection.

In conclusion, your committee are of the opinion that a large amount of this corrosion could be prevented by the care and attention of the men running the engines. It is the practice on some of the railroads to completely drench the coal with water, in order to lay the dust. When this is found necessary, and water could be used with moderation, the life of a tank would be much longer.

W. J. ROBERTSON,
ALBERT GRIGGS,
O. STEWART,
JEROME WHEELOCK.

On motion, the report was received.

MR. LEWIS—I move, Mr. Chairman, that the discussion on this subject be dispensed with.

The motion was carried.

PURIFICATION OR SOFTENING OF FEED WATER.

THE PRESIDENT—The next subject is "The Purification or Softening of Feed Water."

SECRETARY SINCLAIR—I have a communication from Mr. Quackenbush, one of the members of the committee, to the effect that they are unable to

send in any report on this subject. The committee had collected a great deal of information and devoted a great deal of time to the subject, and when it was about ready for preparation, Mr. Small, the chairman of the committee, met with an accident which confined him to bed, and has ever since, and that prevented the report from being made up. Consequently I have to intimate that no report will be given.

MR. SWANSTON—I move that the subject and the committee be continued till next year.

The motion was carried.

THE PRESIDENT—The next subject is "The Best Form and Size of Axles for Heavy Tenders."

The report on this subject was read by Mr. Pomeroy, as follows:

AXLES FOR HEAVY TENDERS.

Your committee, to whom the subject of "The Best Form and Size of Axles for Heavy Tenders" was referred, prepared the following circular and sent it to the members of the Association and others:

1. Are you in favor of an Axle for HEAVY TENDERS with or without end collars? Answer ....

2. If in favor of an Axle WITH END COLLARS, please give figures for the following dimensions: (A) Diameter of END COLLAR ....in.

(B) Diameter of JOURNAL ...in.	(G) Length of JOURNAL ...in.
(C) " DUST-GUARD-SEAT.in.	(H) " DUST-GUARD-SEAT.in.
(D) " WHEEL-SEAT .....in.	(I) " WHEEL-SEAT ......in.
(E) " CENTER OF AXLE...in.	(J) " from center to center JOURNAL....ft ...in.
(F) Length of END COLLAR..in.	

(K) Length of AXLE over all. ....ft......in.

3. If in favor of a collarless Axle, please give the dimensions as above, except the (A) and (F). Also kind of end stop and manner of fixing same.

....

4. Which one of the three forms in use (given below) of form of Axle between the wheels do you approve? And why?

5. What is the limit of weight on journals per square inch of contact?

....

By a heavy tender your committee understands one that,

when loaded, will carry, say about 3,600 gallons of water and about 16,000 lbs. of coal.

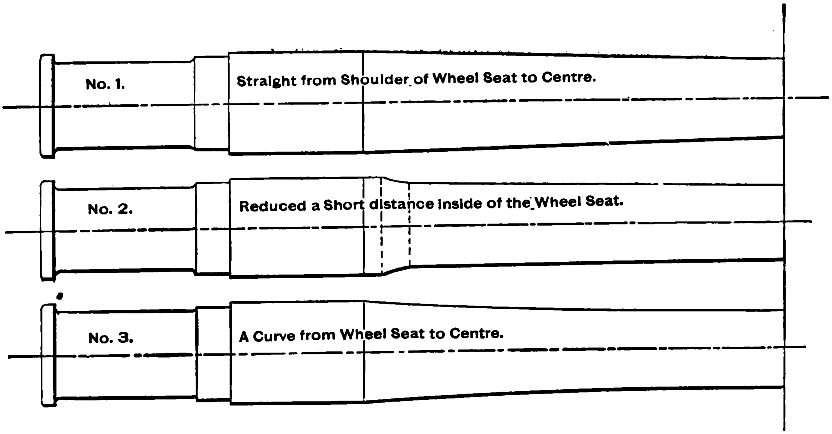


Fig 16.

To this circular your committee have received thirty-six answers, and of these seventeen express in favor of the Master Car Builders' standard axle for cars of 60,000 lbs. capacity, as adopted last year; ten are in favor of the same general form of axle with slight changes in the dimensions, but no two of these ten agree; three favor the M. C. B. axle for 40,000 lbs. capacity cars. Thus, we have thirty replies in favor of axles with collars and the remaining six in favor of axles without collars. Of the dimensions given by those in favor of the collarless axle, no two are agreed, nor do they agree in regard to the end stop, as each has a different design.

The blue prints sent to the Committee are forwarded for the inspection and information of members at the Convention.

There are twenty answers to the question of limit of weight per square inch of contact, and these vary from 170 lbs. to 350 lbs., showing a wide diversity of opinion, and that the question was not viewed from the same standpoint by those making the answers.

Your committee would recommend 300 lbs. as a safe standard for limit of weight per square inch of contact, and recommend that this contact be equal to the diameter of the journal. With

a journal $4\frac{1}{2}$ inches by eight inches the weight per square inch of contact, with a tender of the dimensions in our circular, would be about 225 lbs. per square inch; this would vary, according to the construction, but there would be ample margin for safety and good results as to wear.

To the question as to the form of axle between the wheels, there are thirteen for form No. 1; two for form No. 2, and thirteen for form No. 3, making twenty-eight answers to this question. Your committee are of the opinion, however, that form No. 1 is the correct one. The question of form between wheels was suggested at the time the circular was under consideration by one of the members of your committee having several bent and broken axles of forms Nos. 2 and 3 in his shop. Since then we have found that the Pennsylvania Railroad had noted on their blue prints the adoption of form No. 1, and your committee asked from Mr. A. S. Vogt, Mechanical Engineer, Altoona, and from Mr. Edward Graftstrom, Chief Draughtsman of the P., C. & St. L., and C., St. L. & P., Pennsylvania Lines West of Pittsburg, the reason which led to the change, and attach their answers as part of our report.

Your committee would then recommend the adoption of the Master Car Builders' axle for cars of 60,000 lbs. capacity, with form No. 1 between the wheels as the proper dimensions and form for an axle for heavy tenders.

This will be also in the interest of economy, as the car and tender axle of heavy capacity will be interchangeable and no special axle for this purpose will have to be carried in stock.

(Signed) W. SWANSTON,
W. GARSTANG,
JAS. MAGLENN,
L. R. POMEROY,
Committee.

The following are the letters referred to in the report. Mr. A. S. Vogt writes:

There has from time to time been much complaint about axles used by the Pennsylvania Railroad Company being weak, and we have a few of the large size with 4x8 inches journals broken in service. This break has gen-

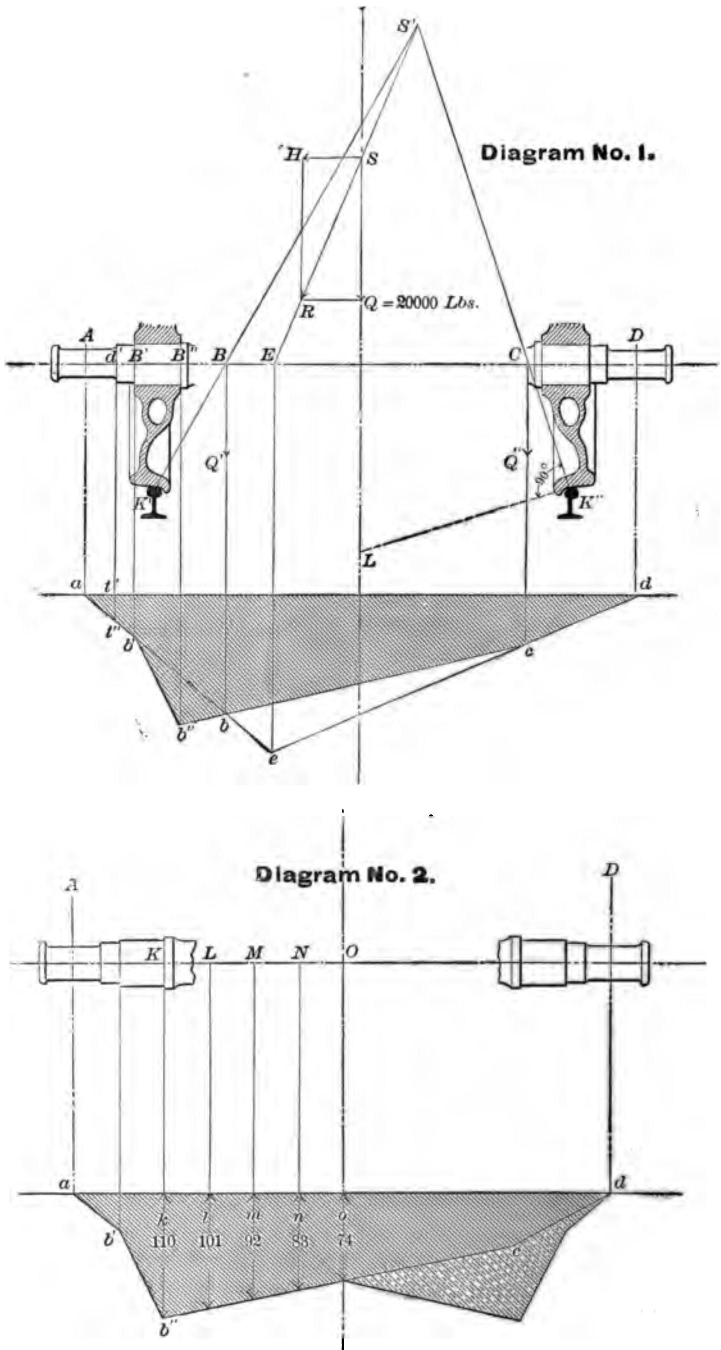


Fig. 17.

erally taken place, especially in the iron axles, half way between the centre of the axle and the inside hub of the wheel; this is also a favorite place for the axle to bend. Some time over a year ago, we made a very thorough investigation of the dimensions required for car truck axles, taking into consideration, not only the static loads, but also the shocks against the flanges of the wheels caused by the striking of curves and points of the frogs in yards, also allowing for the forces acting in a horizontal direction through the center of gravity of the car, all of which make it necessary to make the large diameter of the axle directly at the inner end of the wheel fit, but the same investigation also shows that the axle can be gradually diminished in diameter toward the center; this reduction in size proceeds in a way which causes the outline of the axle to assume a curve, resembling a very flat parabola. The trouble has been with our axles in the past that they did not receive any mathematical investigation, but were simply guessed at, and although the shape approached a true one, it was not quite right; this curve was the principal error, and the investigation showed that it should be a great deal flatter than what we had it; in fact, so much so, that it is nearly a straight line, and we made it so. That part of the axle, therefore, resembles two truncated cones joined at the small end.

I think you will also find that a shape proposed by the Master Car Builders as their standard for the 60,000 lbs. cars is the same shape, and this form of axle is shown on plate No. 8, and described on page No. 211 of the Master Car Builders' Report of 1889.

Mr. Edward Graftstrom writes:

CALCULATION OF CAR AXLES.

Referring to your inquiry, why the first form of axle shown on your circular is the most correct, I would give you the following graphic demonstration:

A D is the center line of the axle (see diagram No. 1), and S is assumed to be the center of gravity of the car. If the car weighs 80,000 lbs. loaded, each axle would support a weight of 20,000 lbs., represented in the diagram by Q. Besides this weight, each axle is acted upon by a horizontal force H, caused by the centrifugal force in curves and by the swinging motion of the car. This force H has by Adam Scheffler's experiments at Braunschweig, Germany, been found to be as high as 0.4 of the load. The resultant of the force H and the weight Q is represented by the line and direction R.

If R is divided into components going through the rail heads, it is apparent that the component through the rail K″ from which H is turned must be normal to the surface of the rail in contact with the wheel, or in other words, the force R must be moved upward in its own direction until the angle S′ K″ L is equal to 90°. The two components of R would then act along the lines S′ K′ and S′ K″. These lines intersect the center line of the axle at B and C, and are here divided into vertical components Q′ and Q″, besides horizontal

components, which may be left out of consideration, as they do not affect the action.

From the point E, where R extended intersects the center line of the axle, a vertical line E *e* is dropped to some point below *e* below a line *a d*, drawn parallel to the axle. Points *a* and *d* are the projections on this line of the center points of the journals, so that *a d* is equal to A D, and *a* and *d* are connected with *e*, forming the triangle *a d e*. Q′ and Q″ are extended to C and *c*, which points are connected by the line C *c*. If vertical lines are now drawn from the wheel fit B′ B″ to points C′ on *a e* and C″ on the extension of C *c*, then the polygon a C′ C″ *c d* is formed. This polygon determines the correct axle for the weight Q and the force H, as will be shown. But as H is liable to act in either direction, and both halves of the axle must be made alike, the polygon takes in reality the shape shown on diagram No. 2.

In order to ascertain the shape of the axle, the distance between the wheel fits is divided in a number of equal parts (see diagram No. 2). From each of these division points a vertical line is drawn through the polygon. According to F. Reuleaux, the diameters of the axle at the different points K, L, M, N, and O, stand exactly in the same proportion to each other as the cubic root of the distances *k*, *l*, *m*, *n*, and *o*, or expressed mathematically:

$$\frac{\text{Diameter at K}}{\text{Diameter at L}} = \sqrt[3]{\frac{k}{l}}$$

In the case of the Master Car Builders' axle the diameter at K is 4⅞″, *k* scales on the diagram 110, and *l* scales for 101 hundredths of an inch. Thus:

$$\frac{4\frac{7}{8}}{\text{Diameter at L}} = \sqrt[3]{\frac{110}{101}}$$

And diameter L=4.73″.

In a similar manner the diameters at M, N and O are found to be 4.59″, 4.44″ and 4.29″ respectively. If an axle is laid out according to these dimensions, you will find that it will conform very closely with the straight taper of of the Master Car Builders' standard axle.

On motion the report was received.

DISCUSSION ON AXLE FOR HEAVY TENDERS.

Secretary Sinclair—I would direct the attention of the members to the fact that the accepting or adopting this report involves the adopting of the Master Car Builders' standard.

Mr. Swanston—I would say in connection with this report that at the last meeting the question seemed to be whether this Association would endorse the standard that had been adopted by the Master Car Builders' Association, and the intention of this report is to corroborate or sustain their 60,000 lb capacity axle for heavy tenders.

Secretary Sinclair—I move that the report be adopted and the standard

or the Master Mechanics' Association that is recommended in it be adopted by the Association.

The motion was seconded.

THE PRESIDENT—State the motion again, Mr. Sinclair.

SECRETARY SINCLAIR—The motion essentially is that I propose that the axle recommended be adopted as the standard of the Association.

MR. FORNEY—Is it quite clear from this report what the dimensions of that axle are?

THE PRESIDENT—It says the 60,000 lb. car axle of the Master Car Builders' Association.

MR. MACKENZIE—The motion does not so state it.

MR. SWANSTON—The figures are not in there, but the standard axle for a 60,000 lb. car adopted by the Master Car Builders' Association is the one referred to.

MR. FORNEY—I quite agree with you, but there is nothing in the report that indicates that that is the axle that is adopted.

SECRETARY SINCLAIR—I must refer you to the clause of the report next to the last, and I think that makes it clear enough.

MR. FORNEY—If that be the case, why does not Mr. Sinclair embody that in his resolution? Mr. Sinclair has stated that we recommend the Master Mechanics' standard axle. I think that would leave it very ambiguous as to what the Master Mechanics' standard axle was. I would amend the motion of Mr. Sinclair by moving that the recommendation of the committee be adopted.

MR. BARNES—This is rather an important matter, and as there is a small number of members here, I would like to amend that by moving that the subject be referred to letter ballot.

MR. MACKENZIE—There is no such thing in our Association.

MR. HICKEY—I don't think we ought to adopt any standard axle without first giving the dimensions. It is true that the Master Car Builders have adopted an axle for 60,000 lb. cars, and I find no fault with it. But before an Association of this sort goes on record as adopting anything, it appears to me they ought to have a blue print or something defining the axle—its length, its wheel fit, and all features relating to it. The mere statement that we are going to adopt something that somebody else has adopted, without stating definite figures, I do not think is right.

MR. MACKENZIE—It seems to me that that is not relevant. The Master Car Builders have adopted a standard axle and we all know what it is. If we simply endorse the action of the committee in recommending an axle, that axle will certainly be the one adopted by the Master Car Builders. The figures are plain enough. There are lots of blue prints and lots of cuts of the axle. All we want to do is to approve the recommendation of the committee and endorse the Master Car Builders' standard axle for a 60,000 lb. car or tender. (Applause.)

MR. HATSWELL—We are not all Master Car Builders. A great proportion

of us are Master Mechanics. Give us some data so as to let us know what we are voting on, and let us have an Association of our own. (Applause.)

THE PRESIDENT—The question is to adopt a standard axle for a 60,000 lb. car of the Master Car Builders' Association for our heavy tenders, as recommended by the committee.

MR. RANDOLPH—I would like to make an amendment to that. I would suggest that the details and drawings of that axle be included in this report.

MR. MACKENZIE—I accept the amendment.

MR. FORNEY—I dissent from the chair with a good deal of reluctance, but it seems to me that the question before the house is the amendment to Mr. Sinclair's resolution. That amendment was that the recommendation of the committee be adopted. I think that is the resolution before the house—that the recommendation of this committee be adopted.

MR. SETCHEL—If I can meet with a second I would move to amend, that the recommendation of the committee be submitted to letter ballot the coming year.

MR. HATSWELL—I second that motion.

MR. MACKENZIE—Is there any provision for letter ballot in the Master Mechanics' Association?

MR. SETCHEL—There is no special provision.

MR. MACKENZIE—Then you will have to amend the Constitution.

MR. SETCHEL—Not at all.

MR. MACKENZIE—I call for a rising vote on the amendment, Mr. President. That will settle it.

THE PRESIDENT—The first action you will take will be on Mr. Setchel's amendment—that these propositions be submitted to the members by letter ballot. All who are in favor of that amendment will make it known by rising to their feet; those opposed in the same manner.

The amendment was lost, only two members voting for it.

THE PRESIDENT—Now the next question is on the amendment of Mr. Forney. What was your motion, Mr. Forney?

MR. FORNEY—My motion was that the recommendation of the committee be adopted; which is as follows:

"Your committee would then recommend the adoption of the Master Car Builders' axle for cars of 60,000 lbs. capacity with form No. 1 between the wheels as the proper dimensions and form for an axle for heavy tenders."

SECRETARY SINCLAIR—Mr. Randolph proposed an amendment to your motion that blue prints and engravings giving the particular parts of the axle be incorporated in the committee's report.

MR. FORNEY—You are right, sir. I accept that.

THE PRESIDENT—Now, gentlemen, you all understand the question before the house. All those in favor of that will make it known by rising to their feet.

The motion was carried unanimously.

(An engraving of the axle adopted will be found among the other standards at the end of this volume.)

THE PRESIDENT—If there is no further discussion of this question now, it will be closed. The next question before the house is "The present status of the automatic car coupler question, and whether this Association can endorse the action of the Master Car Builders' Association in recommending the vertical plane type as a standard, from a mechanical standpoint."

AUTOMATIC CAR COUPLERS.

MR. HICKEY—I have to say that the committee have no regular report to make. I also desire to say that this has not occurred because of any lack of energy or any lack of interest in the subject, but it is because we were unable to get a sufficient amount of reliable data on which to base a report. Now, rather than undertake to submit to this Convention a report that would be unreliable, we concluded not to report at all—that is, further than explaining our position. In connection with that, I would like to say, that if the committee is to be continued until next year, which the committee said to me they would like to have done, I would like every member of the American Railway Master Mechanics' Association to get all the information he possibly can on that very important subject; to post themselves fully on the present status of it, and not only on the present status of it, but on its mechanical construction. It is one of the most important questions, to my mind, today before the American Railway Master Mechanics' Association or any other. (Applause.) It is a question, gentlemen, that we cannot much longer avoid. We have got to face that issue. We have got to place ourselves on record on a question so important not only to all railway interests, but to the American nation. I would therefore request that if we are to be continued, you post yourselves on everything relating to it and support the committee the latter part of the year by answering the questions that they will present to you in due time—answer them fully and give all the information that you possibly can.

MR. SETCHEL—I move that the verbal report of the chairman of the committee be accepted, and that the committee be continued another year.

MR. PECK—I second that motion.

MR. MACKENZIE—May I say a word here? I presume that many of you recognize the fact that there are Master Mechanics belonging to this Association who represent the car department, and Master Mechanics representing car departments that are putting the vertical car hook on their cars today. Now, what are we to say to our general managers when we fail to endorse the very thing we are required to do by our general managers? It seems to me that as an Association we should endorse the action of the Master Car Builders in their vertical type of coupler, from the very fact that many of us are handling that department and that we are required to put it on to the cars. Now, what harm can it do? I want to ask in a mechanical way, what harm can it do for us to endorse the Master Car Builders' vertical type of coupler?

It seems to me that we can do no more than to say as a body that we endorse the action of the Master Car Builders. I know that we are putting the coupler on our cars, and I know that we are putting it on because the railroad managers say that we shall do it, and if the Association say that they endorse the action, they will feel that we have an interest in it and are doing what is right.

MR. SETCHEL—I would suggest to Mr. Mackenzie that there are a great many individual members of this Association that are doing, and some of them are required to do, things that this Association never would endorse, not in years to come, and that we ought to look at this matter as an Association and see whether we should simply exist as endorsers of the Master Car Builders, or whether we shall exist as an Association bound to investigate and give a reason for every action that we take. (Applause.)

MR. BUSHNELL—I would like to ask one question, whether it is within the province of the Master Mechanics' Association to decide on car couplers or whether it is a criticism upon the Master Car Builders' Convention that we are acting upon?

MR. HICKEY—In answer to Mr. Bushnell I would like to read this one Article in the Constitution. Article 2 of the Constitution says:

"The objects of this Association shall be the advancement of knowledge concerning the principles, construction, repair and service of the rolling-stock of railroads by discussions in common; the exchange of information, and investigations and reports of the experience of its members; and to provide an organization through which the members may agree upon such joint action as may be required to give the greatest efficiency to the equipment of railroads which is entrusted to their care."

That includes cars as well as locomotives.

On motion the discussion was closed.

SECRETARY SINCLAIR—Gentlemen, that finishes the business of reading reports of committees, with the exception of the committees appointed at this Convention—an Auditing Committee and a Committee on Resolutions.

THE PRESIDENT—We will hear the Auditing Committee's report.

REPORT OF AUDITING COMMITTEE.

Mr. Barnett presented the report of the Auditing Committee, as follows:

Your committee have audited the accounts of the Secretary and Treasurer for the past year and found them correct.

J. DAVIS BARNETT,
R. W. BUSHNELL,
WILLIAM SWANSTON,
Committee.

On motion the report was received.

REPORT OF COMMITTEE ON RESOLUTIONS.

Mr. John A. Hill submitted the report of the Committee on Resolutions:

Your Committee on Resolutions beg leave to submit the following:

Resolved, That the thanks of the American Railway Master Mechanics' Association be heartily and unanimously tendered to President M. E. Ingalls, of the Chesapeake & Ohio road, for his cordial address of welcome to our organization; to the Rev. George Royal, for his fervent petition to the Most High in our behalf; to William Garstang, Superintendent of Motive Power, Chesapeake & Ohio, for his untiring efforts in securing transportation and the privileges of the railroad and steamboat lines for our members and their families; to the Richmond Locomotive and Machine works for the enjoyable entertainment and banquet at their works; to our commercial friends and their various committees, who have been so painstaking and successful in the entertainment of the members and their families; and to the editor and proprietors of the *Northwestern Railroader*, for their enterprise in supplying a daily report of our meetings.

JOHN A. HILL,
WILLARD A. SMITH,
A. W. GIBBS,
Committee.

On motion the report was received.

VOTE OF THANKS TO COMMITTEE ON COMPOUND LOCOMOTIVES.

Mr. Hickey—While resolutions are in order, I have heard some resolutions of thanks tendered to two of our committees. We had a very important subject before this Association yesterday or the day before; that was the question of compound locomotives. It was a question of deep interest, and it required a great deal of effort to get the report up, and if I am now in order I would move a resolution of thanks to members of the committee for their energy and industry in producing so much information in regard to compound locomotives as was embodied in that report.

The motion was carried.

ELECTION OF OFFICERS.

THE PRESIDENT—Gentlemen, the election of officers is the next thing in order. Mr. James Meehan, Mr. Setchel and Mr. Hickey will be the tellers for the coming election. Gentlemen, you will prepare your ballots for President.

The Convention proceeded to ballot for President, with the following result, as announced by Secretary Sinclair:

The report of the tellers shows the vote to be as follows: R. H. Briggs, 7; John Hickey, 5; John Mackenzie, 27; J. Davis Barnett, 1; A. Griggs, 3; J. H. Setchel, 1; William Swanston, 2; J. N. Barr, 1; James Meehan, 1.

Mr. John Mackenzie having received a majority is elected President.

On motion of Mr. Sinclair the election was made unanimous.

In response to repeated calls for a speech, Mr. Mackenzie rose and said:

Gentlemen, I do not know how to thank you for the continued confidence you seem to place in me. I do not know that I can say anything more than that I am very much surprised that you should put me in the chair. I would very much rather be on the floor, where I can talk a little bit once in a while. It seems as though you want to get me where I can't talk, but I will be with you all the same, if I have health. If there is anything I can do to further the interests of the Association in the way of assisting the members in their reports, or making reports, I would be glad to do it, I am sure. Again allow me to thank you from the bottom of my heart.

A ballot was then taken for First Vice-President. Several ballots were taken before an election took place.

SECRETARY SINCLAIR—Fifty-two members have voted; 37 for John Hickey; Albert Griggs, 3; William Garstang, 7; James Meehan, 4; J. N. Barr, 1. John Hickey is elected.

THE PRESIDENT—I have the pleasure of announcing that Mr. John Hickey will be your next First Vice-President.

A MEMBER—I move that the election be made unanimous by a rising vote.

The motion was carried,

In response to calls for a speech, Mr. Hickey said:

Mr. President, and gentlemen of the American Railway Master Mechanics' Association, to say that I thank you for this great honor is expressing my sentiments very poorly. I deeply feel the honor that you have conferred on me. I trust that I will be able to fill that office in a way that will be acceptable to the Association. Since my first connection with the American Railway Master Mechanics' Association I have had some work to do in connection with it, and my highest ambition has been not only to perform my duties that I had to do but to perform them well. Gentlemen, that is the secret of a successful organization, and if we perform our duties well, I think that we will have an organization by and by that will be second to none, not only in this country, but in the world. I trust, therefore, that any duties that fall upon me

to perform I shall perform well, and I again thank you heartily for this great honor that you have conferred upon me. (Applause.)

The balloting for Second Vice-President resulted as follows:

Whole number of votes cast, 56; W. H. Thomas, 1; J. N. Barr, 2; T. W. Gentry, 3; Albert Griggs, 7; James Meehan, 9; William Garstang, 34.

THE PRESIDENT—I have the pleasure of announcing that Mr. Garstang is elected Second Vice-President for the ensuing year.

MR. PECK—I move that it be made unanimous.

The motion was carried by a rising vote.

MR. GARSTANG—Mr. President and members of the Association, I thank you very much for the honor you have conferred on me. All that I can say is that I will endeavor to further the interests of the Association to the best of my ability. (Applause.)

THE PRESIDENT—The next officer to be elected is the Treasurer for the ensuing year.

MR. MACKENZIE—If I am in order, I move that the President be authorized to cast the ballot for Mr. Stewart for Treasurer.

The President cast the ballot of the Association for Mr. Stewart.

THE PRESIDENT—Mr. Stewart, you are elected Treasurer for the ensuing year of the American Railway Master Mechanics' Association.

MR. STEWART—Without bonds? Well, gentlemen, I thank you for the confidence you have exhibited in my ability to perform the arduous duties of Treasurer—notwithstanding I am very close to the Canada line, only about six hours. I will receive and disburse whatever funds you may put in my possession according to the best of my ability for the interests of the Association. (Applause.)

THE PRESIDENT—The next officer to be elected, gentlemen, is the Secretary.

MR. SWANSTON—I move that the same course be pursued, and that the President be allowed to cast the ballot for Mr. Angus Sinclair.

The motion was carried by a rising vote.

THE PRESIDENT—I announce, gentlemen, Mr. Angus Sinclair as your Secretary for the ensuing year. (Applause.)

SECRETARY SINCLAIR—Mr. President and gentlemen, I have done so much talking at this Convention that I am sure you will be glad if I make my remarks short. Therefore, I only say that I heartily thank you for the honor which you have conferred upon me, and the manifestation you have made of your continued confidence in the way I am carrying on the work laid out for me to do.

REPORTS TO BE SENT TO SECRETARY NOT LATER THAN MAY 1ST.

MR. SHORT—I have a resolution to offer.

Resolved, That the chairmen of committees be required to send their reports to the Secretary not later than May 1st, 1891; and that the Secretary be instructed to have reports printed and sent to members in time to be read before the convention meets.

The motion was seconded by Mr. Lewis.

SECRETARY SINCLAIR—Before that motion is put I would like to suggest that 1891 be taken out and that it stand as a general order. Then it will do for any year.

MR. SHORT—I accept that.

The resolution was adopted.

MR. SETCHEL—I am very reluctant to say what I am going to say. The matter is now passed and it is a question whether there is any member of this Association who would alter it if it were possible to do so. Yet the very idea I had in offering the amendment to the Constitution has been subverted in the election of the last two officers. The nominating of an individual is postively prohibited by the Constitution as it now stands, but I haven't the slightest idea that anyone desires to alter what has been done. But I give notice to the Association that I will raise the point of order in future whenever I am present when such action is proposed.

THE PRESIDENT—Gentlemen, you now have the privilege of speaking on any subject that will be beneficial to the Association.

The Secretary read an invitation to a complimentary excursion to Virginia Beach, which on motion was accepted with the thanks of the Association.

VOTE ON NEXT PLACE OF MEETING.

A vote taken to test the sense of the meeting as to the place of holding the next convention resulted as follows: Montreal, 5; Put-in-Bay, 1; Buffalo, 1; Cape May, 38.

MR. MACKENZIE—I move that our Secretary be instructed to go some time before the meeting to the place selected by the Executive Committee and secure and reserve a sufficient number of rooms to accomodate the members of this Association and have it understood that the rooms that are reserved for the members shall be held for them, and I would add that the expenses of the Secretary in doing this be borne by the Association.

The motion was carried.

VOTE OF THANKS TO PRESIDENT BRIGGS.

MR. HICKEY—I move that a vote of thanks be tendered to our retiring President for his efficiency during the past year as President of the Association and for the industry and great care and attention he has given to the duties of his office.

The motion was carried by a rising vote, and three cheers were given for the retiring President.

THE PRESIDENT—I have been a member of this Association for several years and I notice one thing—that we have lots of time on our last day. Our business is all done. Nobody is in a particular hurry, and I am a little egotistical and want to flatter myself, probably, that I might have helped you out on that a little. However that is for you to say. I want you to remember one thing—I shall never forget the faces around me here. I am happy that my name is recorded on your books as having been President of this Association. Perhaps we may meet again in convention and perhaps not. We are growing old every day, and many of us will soon be laid away, and the only epitaph I want placed on my grave, if you will contribute to it, is "There lies an honest man," who was president of the Railway Master Mechanics' Association (Applause).

Gentlemen, is there anything else before the meeting.

VOTE OF THANKS TO VICE-PRESIDENT GRIGGS.

MR. HICKEY—I move a vote of thanks be tendered to our retiring First Vice-President, Mr. Griggs.

The motion was carried by a rising vote, and three cheers were given for Mr. Griggs.

The convention then adjourned *sine die*.

(In the first part of this volume the name of Charles Graham, Delaware Lackawanna & Western was missed in the list of members who attended the Annual Convention).

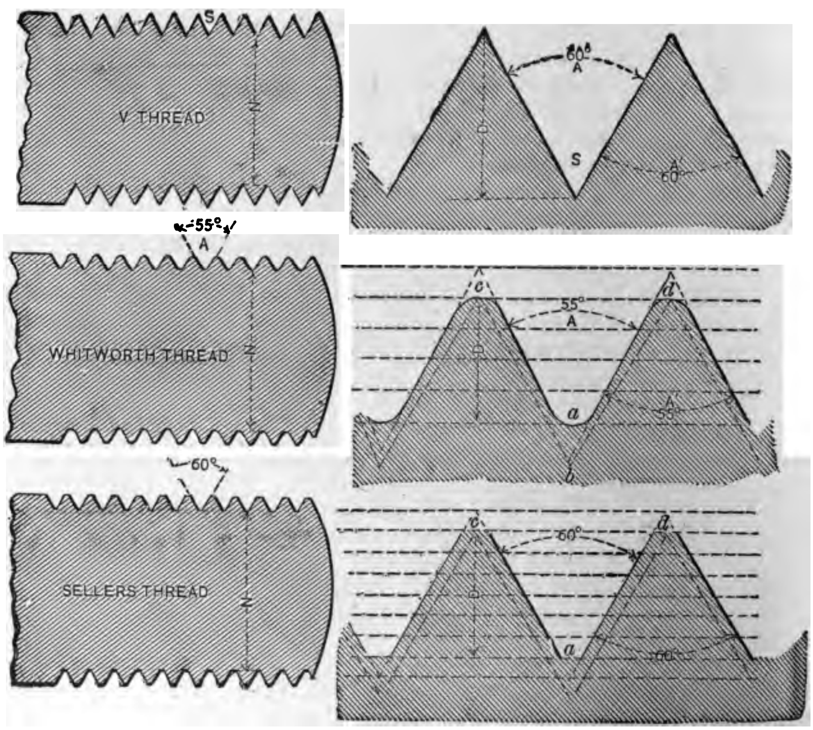
STANDARDS ADOPTED

BY THE

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

SCREW THREADS.

At the Third Annual Convention a report of a committee recommending the United States Standard Screw Thread was adopted. Annexed are the forms and dimensions of the threads in question.



Screw Threads. Sellers' Standard.

SWITCHING ENGINE MILEAGE.

At the Fifth Annual Convention the report of a committee was adopted allowing six miles per hour for switching engines, and six per cent. to train mileage of local freight for switching.

AXLE FOR TENDER TRUCKS.

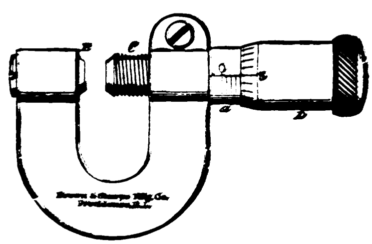
At the Twelfth Annual Convention an axle of the dimensions, illustrated on page 176, was adopted as standard for tender trucks.

JOURNAL BEARINGS, JOURNAL BOX AND PEDESTAL.

At the Fourteenth Annual Convention the journal bearing, journal box and pedestal, illustrated on pages 177, 180, 181 were adopted as standards of the Association.

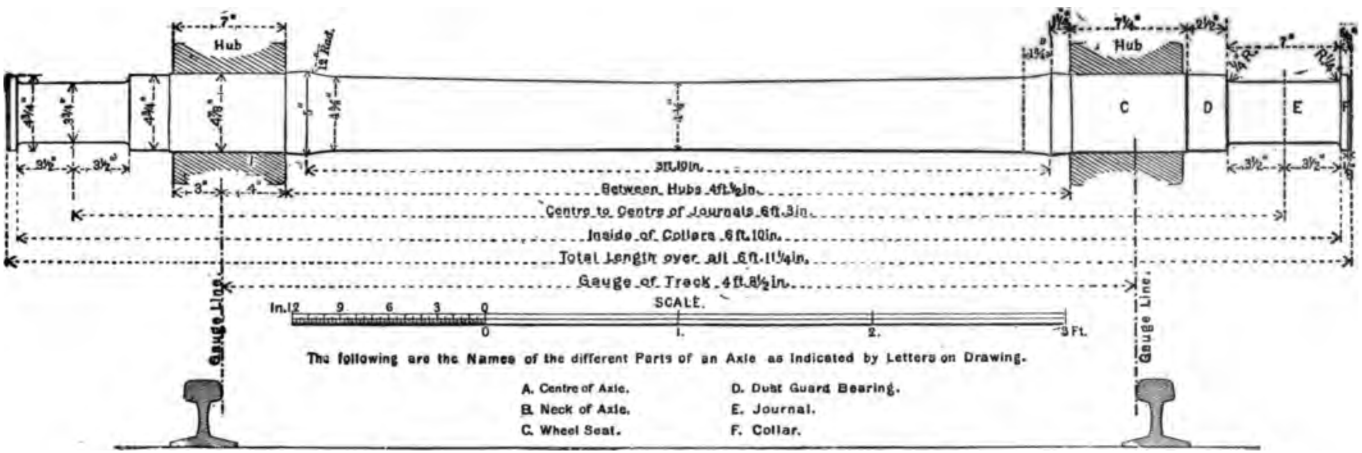
SHEET METAL GAUGE.

At the Fifteenth Annual Convention the Brown & Sharp micrometer gauge shown below was adopted as standard for the measurement of sheet metal.

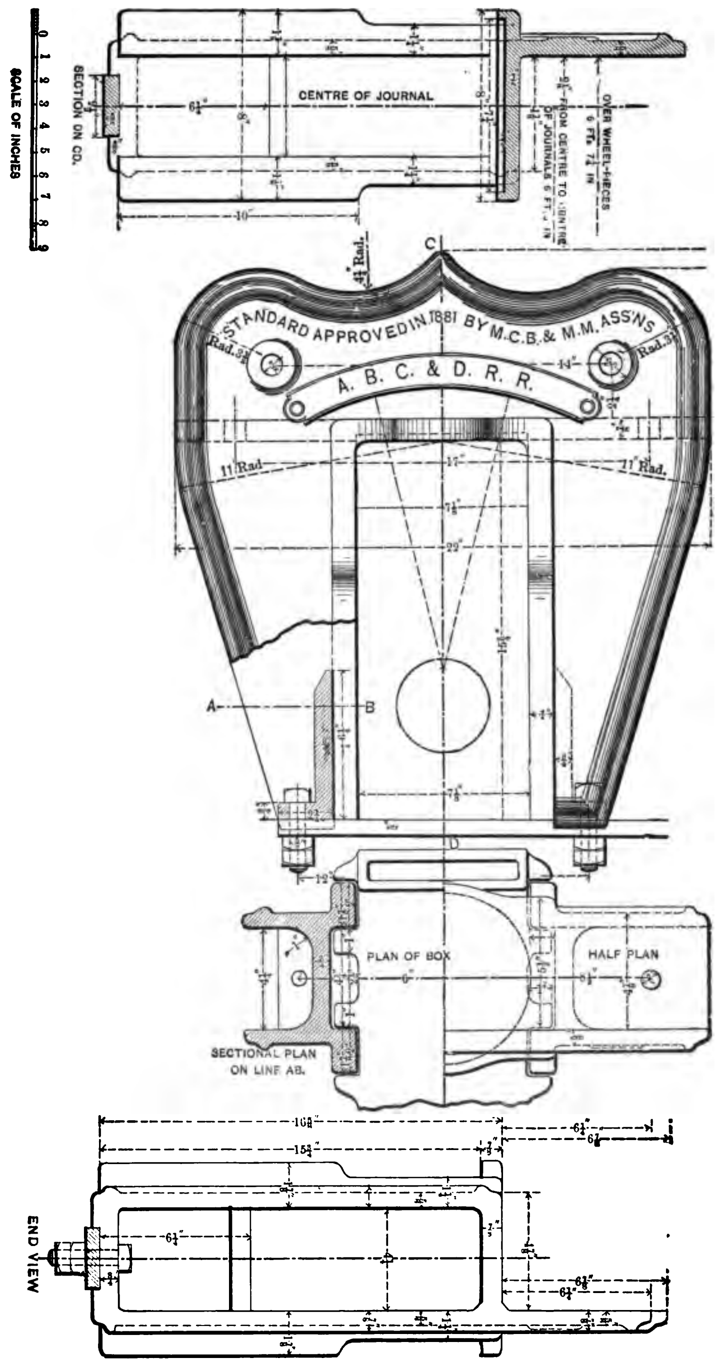


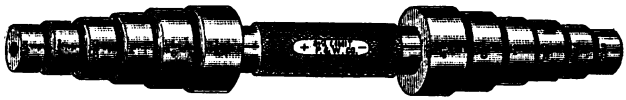
LIMIT GAUGES.

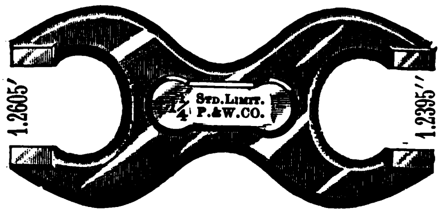
At the Seventeenth Annual Convention the Pratt & Whitney limit gauges for round iron, illustrated on page 179, were adopted. The sizes are as follows:

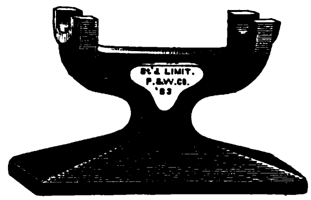


STANDARD AXLE.


SCALE OF INCHES
SECTION ON CD.
CENTRE OF JOURNAL
STANDARD APPROVED IN 1881 BY M.C.B. & M.M. ASS'NS
A. B. C. & D. R. R.
PLAN OF BOX
HALF PLAN
SECTIONAL PLAN ON LINE AB.
END VIEW



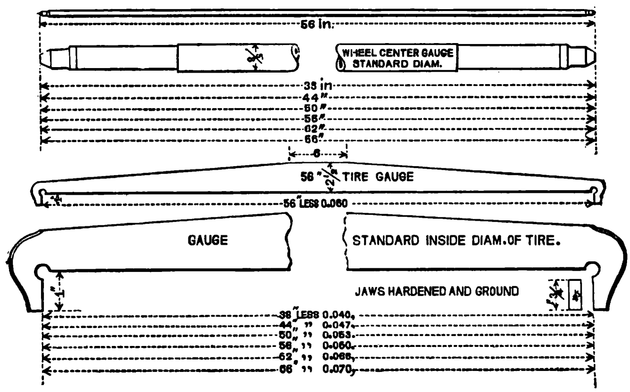




Nominal Diameter. Of Iron. Inches.	Large size. + end. Inches.	Small size. — end. Inches.	Total variation. Inches.
¼	.2550	.2450	.010
5/16	.3180	.3070	.011
⅜	.3810	.3690	.012
7/16	.4440	.4310	.013
½	.5070	.4930	.014
9/16	.5700	.5550	.015
⅝	.6330	.6170	.016
¾	.7585	.7415	.017
⅞	.8840	.8660	.018
1	1.0095	.9905	.019
1⅛	1.1350	1.1150	.020
1¼	1.2605	1.2395	.021

DRIVING WHEEL CENTRES AND SIZE OF TIRES.

At the Nineteenth Annual Convention the report of a committee was adopted which recommended driving wheel centres to be made 38, 44, 50, 56, 62, or 66 inches diameter. At the Twentieth Annual Convention the recommendations of a committee were adopted making tire gauges manufactured by Messrs. Pratt & Whitney, Hartford, Conn., and here illustrated, standards of the Association. The sizes and the allowance for shrinkage are as follows:



SECTION OF TIRE.

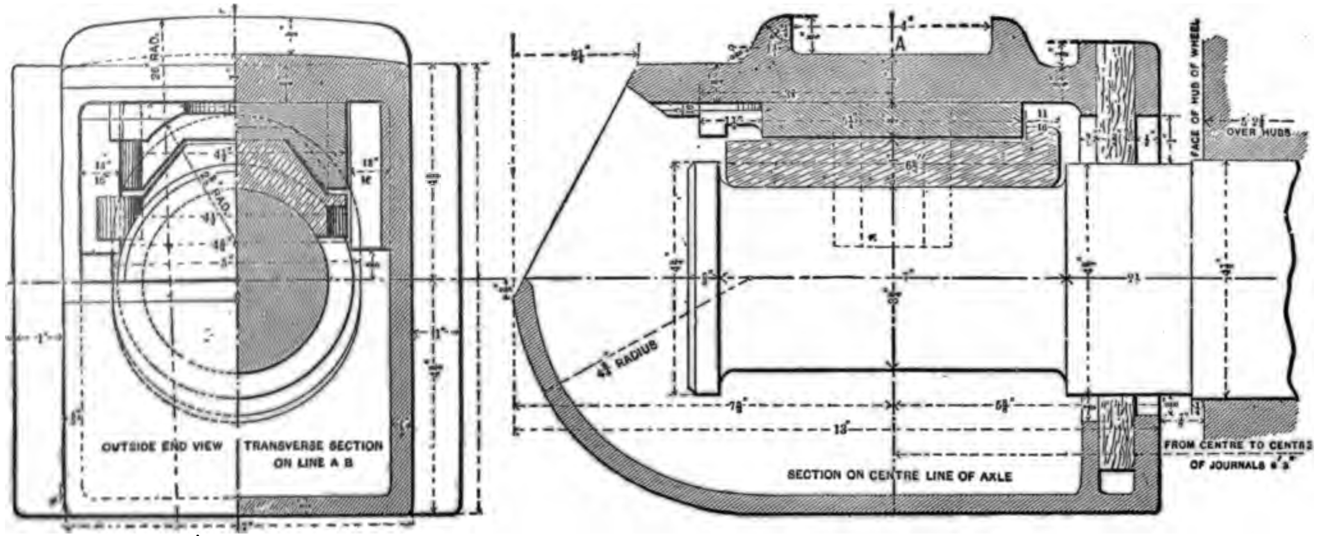
At the Twentieth Annual Convention the standard form of tire section adopted by the Master Car Builders' Association was adopted as the standard of this Association. Annexed engraving, on page 182, gives particulars of the standard.

SPECIFICATIONS, TESTS AND CONTRACTS FOR CAST IRON WHEELS.

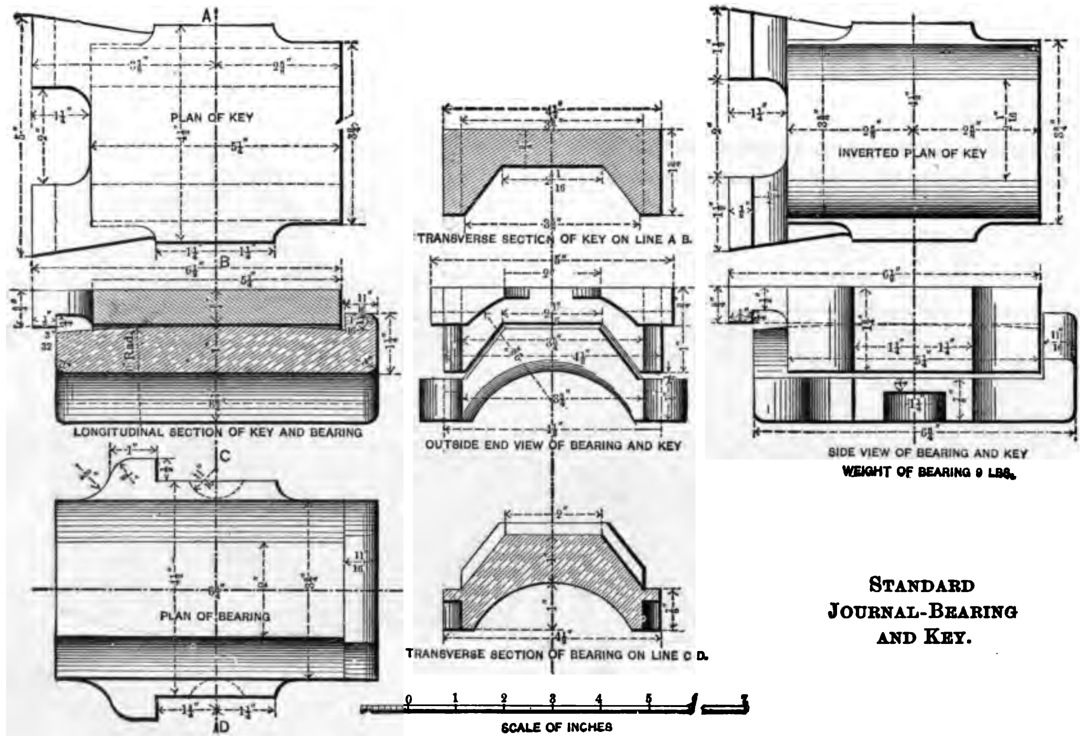
At the Twenty-First Annual Convention a report of a committee was adopted recommending specifications, tests and form of contracts for cast iron wheels. Particulars will be found on pages 151–4 of the Twenty-First Annual Report.

AXLE FOR HEAVY TENDERS.

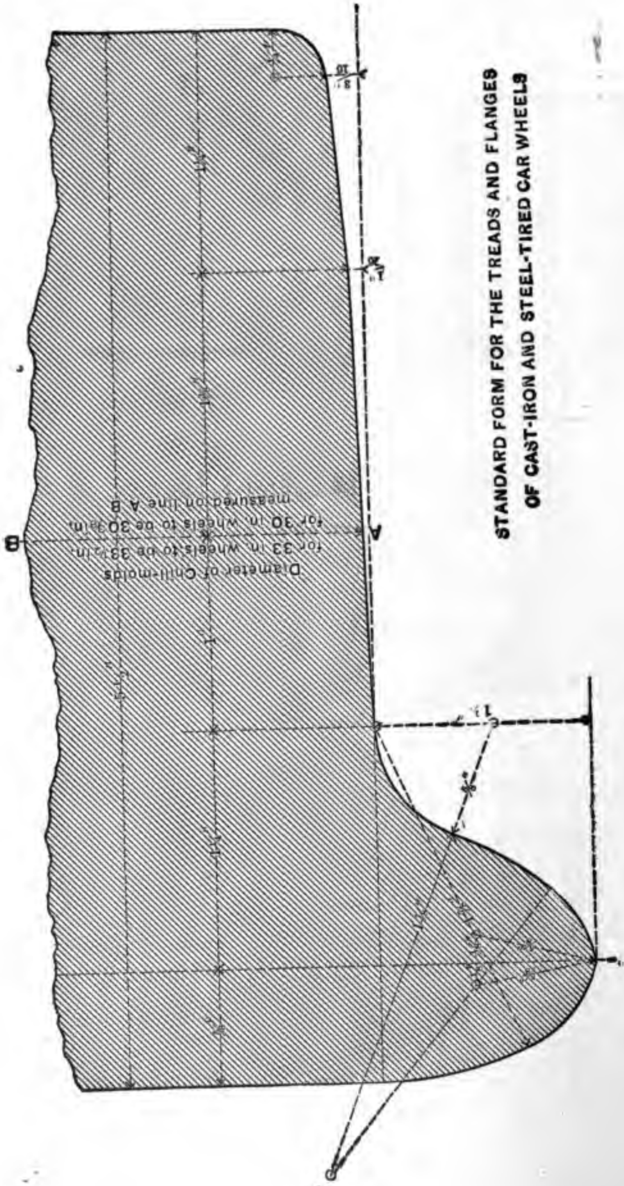
At the Twenty-Third Annual Convention the recommendations of a committee as to the form and dimensions of an axle for heavy tenders were adopted. The engraving, on page 183, gives the dimensions.



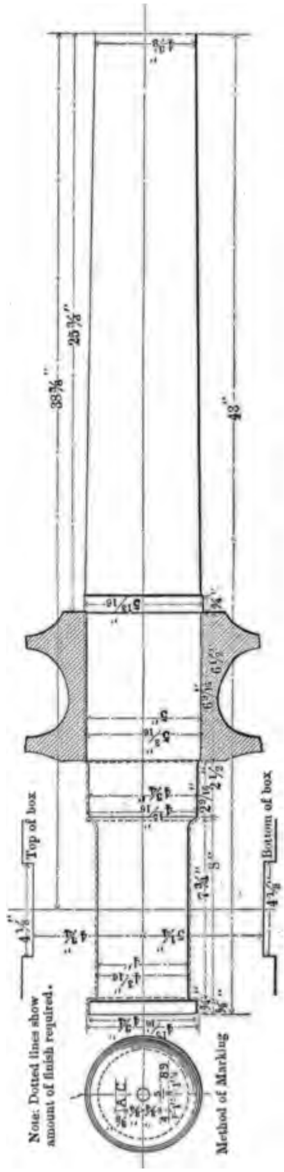
OUTSIDE END VIEW
TRANSVERSE SECTION ON LINE A B
26 RAD.
SECTION ON CENTRE LINE OF AXLE
FACE OF HUB OF WHEEL
OVER HUBS
FROM CENTRE TO CENTRE OF JOURNALS
RADIUS
A



STANDARD JOURNAL-BEARING AND KEY.



STANDARD FORM FOR THE TREADS AND FLANGES OF CAST-IRON AND STEEL-TIRED CAR WHEELS


Top of box
Bottom of box
Note: Dotted lines show
amount of finish required.
Method of Marking

OBITUARY.

H. N. BURFORD.

Mr. H. N. Burford, Superintendent Motive Power and Rolling stock, of the Texas & Pacific Railway, died at Marshall, Texas, September, 6, 1889, in about the fifty-first year of his age. Mr. Burford was born in the State of Virginia in the year 1838, and, at the age of sixteen years or in the year 1854, entered the shops of the Virginia & Tennessee Railway Company at Lynchburg, as an apprentice to learn the machinist trade. After serving a period of three years in these shops, he went to Philadelphia, where he secured a position in the Baldwin Locomotive Works, serving two years under instructions. Leaving the Baldwin works in the latter part of 1859, Mr. Burford returned to Lynchburg and again entered the services of the Virginia & Tennessee Railway in the capacity of gang foreman. He was given an engine to overhaul, and after its completion was placed in charge of it as engineer. In this capacity he served successfully for one year. He was then appointed Division Master Mechanic. Mr. Burford retained this position until November 1870, he then resigned his position with the Virginia & Tennessee Railway and moved to Huntsville, Alabama, where he entered the service of the Memphis & Charleston Railway Company, in the capacity of locomotive engineer and served as such until the spring of 1871, when he accepted the position of Foreman of the shops at Huntsville, for the Memphis & Charleston Railway Company, which position he held until May, 1872, when he was promoted to be Master Mechanic of the Eastern Division still remaining at Huntsville.

Mr. Burford remained in this position, until the Spring of

1876, when the shops of the Memphis & Charleston Railway were consolidated at Memphis. He was then transfered to Memphis and placed in charge of the Motive Power and Car Department of the entire line, with the official title of Master Mechanic.

Mr. Burford continued in this position with great success until May 1888, when he was tendered the position of Superintendent of the Motive Power and Machinery of the Texas & Pacific Railway, which he accepted and held at the time of his death.

Mr. Burford's long period of service as Master Mechanic for the Memphis & Charleston Railway is conclusive evidence of his ability as a manager of the machinery department of a railroad.

Mr. Burford's business life was uneventful, it being confined almost entirely to two roads, rising gradually in the regular line of promotion, through all of the branches from an apprentice, to the position of Superintendent of Motive Power and Rolling-stock, the highest position attainable in the department of railroading which he had. He was a most genial gentlemen, and enjoyed the confidence of all his officers, and made friends with everyone. Mr. Burford's connection with the Texas & Pacific Railway as Superintendent of the Motive Power and Rolling-stock covered a short period of fourteen months, which time was fraught with many reverses. The greatest of these was the loss of his health, yet with all this, the changes that he made were remarkable and valuable to the interest of his Company. By his death the Railway Company lost an efficient officer, and his associates a valued friend.

J. W. ADDIS,
R. H. BRIGGS,
J. C. RAMSEY.
Committee.

JOHN M. SANBORN.

John M. Sanborn was born at Franklin, Merrimack County, N. H., November 1, 1821, where his ancestors, who were of English stock, had resided for several generations.

At the age of seventeen Mr. Sanborn was apprenticed to Aiken Bros., of Franklin, who conducted a general machine shop, to learn the machinist's trade. He remained with Aiken Bros. about one year and then went to the Amoskeag Locomotive Works, where he remained for two years. At the age of twenty he went to North Chelmsford, Mass., and entered the service of Gay & Silver, manufacturers of machinery and tools. In December, 1846, he entered the machine shop of the Nashua Corporation Cotton Factory, of Nashua, N. H., and continued with them until the Summer of 1848, when he was employed by the Boston, Lowell & Nashua Railway Company as locomotive engineer. In the Spring of 1849 he was appointed Foreman of engine house and machine shop on the above named railway; and, at the expiration of two years, was appointed Master Mechanic and Assistant Superintendent. In June, 1867, he resigned this position and went to Wilmington, N. C., as General Foreman of the engine house and shops of the Wilmington & Weldon Railway, and remained there until the Summer of 1869, when he accepted the position of Foreman of engine house of the Lake Shore & Michigan Southern Railway, at Adrian, Mich., and was transferred to Elkhart, in the Spring of 1871 as engine house Foreman at that point. In September, 1872, he accepted the position of Master Mechanic of the Chicago, Danville & Vincennes Railway, where he remained until March, 1873, when he went to Air Line Junction, Ohio, as Foreman of engine house for the Lake Shore & Michigan Southern Railway. In December, 1873, he resigned this position to accept that of Master Mechanic of the Cincinnati, Sandusky & Cleveland Railway, where he remained until November, 1874, when he returned to the service

of the Lake Shore & Michigan Southern Railway Company as Master Mechanic of the Toledo Division, and continued to fill this position until his resignation on November 1, 1889.

Mr. Sanborn had suffered acutely with asthma for several years, and died of that disease on May 12, 1890.

The deceased was prominently connected with the Masonic Order, being a Knight Templar and thirty-second degree Mason. He was an efficient officer, and a man of unswerving integrity both in his business and social life. His kindly nature and many virtues made him a multitude of warm personal friends, who deeply regret his death.

The members of the Railway Master Mechanics' Association tender their sincere sympathy to the widow and children who survive him.

G. W. STEVENS,
W. L. GILMORE,
J. S. GRAHAM,
Committee.

HIRAM M. BRITTON.

On the 10th of August, 1889, occurred the death of a prominent Railroad Manager and one of the founders of the Master Mechanics' Association, Hiram M. Britton.

He was born at Littleton, Mass., November 30, 1831. He attended school until the age of sixteen, when necessity compelled him to begin his life work in earnest. He commenced as an apprentice in the machine shop of the Fitchburg Railroad Company. His natural abilities, his energy and honesty of purpose in all that he did, soon brought him to the notice of his superior officers, and he rapidly advanced in position, filling that of Foreman Engineer and Master Mechanic in succession. In May, 1865, he became Master Mechanic of the Indianapolis, Cincinnati & Lafayette Railway. In June, 1870, he became Superintendent of the Whitewater Valley Railroad, Indiana. In 1875 he was made superintendent of the New York & New England Railroad. In August, 1880, he became General Manager of the New York, Susquehanna & Western Railroad. Finally, in 1883, he was appointed General Manager of the Rome, Watertown & Ogdensburg road. He assumed the management of this road under the most discouraging circumstances. It was in the poorest possible condition, and the receipts were insufficient to meet expenses At the very beginning of his work occurred the terrible Carylon disaster, and many consider the great shock experienced by him at that time as the beginning of the illness which terminated so fatally. Nevertheless, he courageously went to work to improve and build up the road, and in an incredibly short time the effects of his work could be seen in the improvements everywhere manifest. Soon the mileage was doubled; steel rails replaced the iron ones; the rolling-stock was increased, improved and renewed, and business had marvelously increased, until the stock which in the beginning was placed at 15 or 18, was now at par. His incessant labors and untiring devotion to his work was too severe a strain upon his nervous system, and at last the crisis came and he was obliged to go abroad in order to regain his strength. In the company of his wife (who was Miss Harriet F. Smith, of Franklyn, New Hampshire), and Col. C. H. Burtis, he went to Europe in November, 1888, and spent

some time in Nice and in Paris. At first there was a marked improvement in health, but in the Spring it was evident the disease was making rapid inroads. His physician, Dr. Eddy, of Oswego, was sent for by cablegram, and with his care and assistance he began the homeward journey, arriving at Oswego in July. From that time he rapidly grew worse until the end came. Calm, peaceful and resigned, he passed away to receive his reward.

Mr. Britton was one of the six original founders of the American Railway Master Mechanics' Association. The first preliminary meeting was held on June 10. 1868, at which he was present, together with the five other Master Mechanics, Mr. Britton taking an active part in forming into shape what has now become a widely known and useful organization. This meeting was adjourned to meet in the city of Cleveland, Ohio, in the month of September following. At that, the first regularly organized meeting of the Association, consisting of about forty members at its close, Mr. Britton was elected President. His qualifications were such as to fit him in a peculiar manner for that position, and this was so generally recognized and appreciated by the members that he was unanimously re-elected at the succeeding annual meetings of the Association for ten years, and as long as he would consent to serve in that capacity. To his energy and the interest he took in all the business coming before it, the Association is largely indebted for its prosperity in the earlier years of its existance. In his decease our Association has lost one of its most intelligent and useful members.

Personally, Mr. Britton was one of the most genial and affable of men, and at different times he proved himself to possess the most tender and sympathetic nature. The employés of the Company loved him, and while he was in Europe they raised $1,000 to purchase a team and carriage for him on his return. When he learned of this he was most deeply affected.

Mr. Britton is interred in Riverside Cemetery, at Oswego, and over his grave the employés of the road have erected a noble monument to his memory.

G. H. HAZELTON,
N. E. CHAPMAN,
REUBEN WELLS, *Committee.*

COMMITTEES FOR CONDUCTING THE BUSINESS FOR THE YEAR 1890–1.

No. 1. Exhaust Pipes, Nozzles and Steam Passages.

Investigate best form and size in proportion to cylinders.

C. F. Thomas,
A. W. Gibbs,
L. C. Noble,
F. C. Smith,
John Y. Smith.

No. 2. Testing Laboratories, Chemical and Mechanical.

George Gibbs,
Philip Wallis,
G. W. West,
L. S. Randolph,
D. L. Barnes.

No. 3. Advantages and Disadvantages of Placing the Fire-box Above the Frames.

Fred. B. Griffiths,
James Macbeth,
W. A. Foster,
A. G. Leonard,
Louis F. Lyne.

No. 4. Relative value of Steel and Iron Axles.

John Mackenzie,
J. S. Graham,
John S. Cook,
E. B. Wall,
Thomas Shaw.

No. 5. *Purification or Softening of Feed Water.*

W. T. SMALL,
HARVEY MIDDLETON,
A. W. QUACKENBUSH,
J. B. BARNES,
JOHN W. HILL.

No. 6. *The Present Status of the Car Coupler Question.*

Investigate whether this Association can endorse the action of the Master Car Builders' Association from a mechanical standpoint in recommending the Vertical Plane Type as a standard.

JOHN HICKEY,
G. W. RHODES,
SANFORD KEELER,
R. H. BLACKALL,
M. N. FORNEY.

No. 7. *Examination of Locomotive Engineers and Firemen.*

On their duties relating to the use of fuel, care of the locomotive, and ability to deal with disorder or disability of machinery; to what extent practiced, and best plan for conducting the examination.

W. H. THOMAS,
JOHN PLAYER,
F. D. CASANANE,
J. W LUTTRELL,
L. R. POMEROY.

No. 8. *Operating Locomotives with Different Crews.*

Investigate the comparative advantages of operating locomotives with different crews on the "first in and first out" plan, and that of confining men to certain engines, the latter not running a greater number of miles than can be rendered by their regular crews; discuss any improvement in the method of running engines.

ROSS KELLS,
W. W. REYNOLDS,
W. F. TURREFF,
C. G. TURNER,
JOHN A. HILL.

No. 9. Locomotive for Heavy Passenger and Fast Freight Train Service.

Investigate the types best suited for this service, and the relative economy and safety of eight-wheel, ten-wheel and mogul locomotives for the service in question.

PULASKI LEEDS,
JAMES MEEHAN,
E. M. ROBERTS,
C. E. SMART,
W. A. SMITH.

No. 10. Electrical Appliances for Railroad Use.

Report on the progress of electricity into motive power, car lighting, signaling, welding and kindred uses.

T. W. GENTRY,
G. B. HAZLEHURST,
ALBERT GRIGGS,
JOHN ORTTON,
F. W. DEAN.

No. 11. Standards of the Association.

WM. SWANSTON,
WM. GARSTANG,
C. H. CORY,
J. S. MCCRUM,
THOMAS SHAW.

Obituary—H. N. Burford.

J. W. ADDIS,
R. H. BRIGGS,
J. C. RAMSEY.

Obituary—J. M. Sanborn.

G. W. STEVENS,
W. L. GILMORE,
J. S. GRAHAM.

Obituary—H. M. Britton.

G. H. HAZELTON,
N. E. CHAPMAN,
REUBEN WELLS.

Disposal of Boston Fund.

J. N. LAUDER,
J. N. BARR,
ANGUS SINCLAIR.

To Confer with Committee of Master Car Builders' Association on Bringing Conventions Closer Together.

O. STEWART,
CHARLES GRAHAM,
DAVID CLARK,
G. W. STEVENS,
JOHN MACKENZIE.

On Subjects for Investigation and Discussion.

WILLIAM H. LEWIS,
JOHN WILSON,
PETER H. PECK.

Executive Committee and Trustees of Boston Fund and Printing Fund.

JOHN MACKENZIE,
JOHN HICKEY,
WILLIAM GARSTANG,
O. STEWART,
ANGUS SINCLAIR.

Custodian of Boston Fund.

J. H. SETCHEL.

NAMES AND ADDRESSES OF MEMBERS.

NAME.	ROAD.	ADDRESS.
Addis, J. W.	Texas & Pacific	Gouldsboro, La.
Agnew, J. H.	South Carolina	Charleston, S. C.
Aldcorn, Thos.	West Shore	New Durham, N. J.
Ames, L.	Beech Creek	Jersey Shore, Pa.
Arp, W. C.	C., St. L. & P.	Logansport, Ind.
Atkinson, R.	Canadian Pacific	Montreal, Que.
Augustus, W.	Keokuk & Western	Centerville, Ia.
Austin, W. L.	Baldwin Locomotive Works, Philadelphia, Pa.	
Ball, A. W.	N. Y., L. E. & W.	Galion, O.
Barnes, J. B.	Wabash	Springfield, Ill.
Barnett, J. Davis	Grand Trunk	Stratford, Ont.
Barnett, T. E.	Canadian Pacific	Vancouver, B. C.
Barr, J. N.	C., M. & St. P.	Milwaukee, Wis.
Battye, John E.	Shenandoah Valley	Milnes, Va.
Bean, John	C. & Canton	Canton, Ohio.
Bean, S. L.	Northern Pacific	Fargo, N. Dak.
Beckert, Andrew	Louisville & Nashville	Decatur, Ala.
Bisset, John	W., W., C. & A.	Wilmington, N. C.
Black, John		Lima, O.
Blackall, R. C.	D. & H. Canal Co.	Albany, N. Y.
Blackwell, Chas.	Penn. & Dallas Aves., Pittsburgh, Pa.	
Boatman, F. P.	Ohio & Miss.	Vincennes, Ind.
Boon, J. M.	West Shore	Frankford, N. Y.
Bradley, S. D.	G. R. & Ind.	Grand Rapids, Mich.
Bradley, W. F.	K. & Michigan	Charleston, W. Va.
Bradt, Joseph		Rochester, N. Y.
Brastow, L. C.	C. of N. Jersey	Ashley, Pa.
Briggs, R. H.	K. C., M. & B.	Memphis, Tenn.
Brook, Geo. B.	B., C. R. & N.	Cedar Rapids, Ia.
Brown, Angus	Northern Pacific	Livingston, Mont.
Brown, F. R. F.	Dominion Bridge Co.	Montreal, Quebec.
Brownell, F. G.	Muncie Street, Muncie, Ind.	
Bruck, Henry T.	C. & Penna.	Mt. Savage, Md.

NAME.	ROAD.	ADDRESS.
Bryan, H. S.	D. & I. Range	Two Harbors, Minn.
Bryant, J. T.	Rich., Fred. & Potomac	Richmond, Va.
Buchanan, Wm.	N. Y. C. & H. R.	New York, N. Y.
Bushnell, R. W.	B., C. R. & N.	Cedar Rapids, Ia.
Campbell, John	Lehigh Valley	Delano, Pa.
Carmody, T.	N. Y., P. & O.	Cleveland, O.
Carson, M. T.	Mobile & Ohio	Jackson, Tenn.
Casanave, F. D.	P., Ft. W. & C.	Ft. Wayne, Ind.
Casey, J. J.	L., N. O. & Texas	Vicksburg, Miss.
Chapman, N. E.		251 S. 4th Street, Philadelphia, Pa.
Chapman, T. L.		
Clark, David	Lehigh Valley	Hazelton, Pa.
Clark, Peter	Grand Trunk	Toronto, Ont.
Clark, Isaac W.	C. F. & Y. V.	Fayetteville, N. C.
Clifford, J. G.	L. & Nashville	Mobile, Ala.
Cloud, Jno. W.		Rookery Building, Chicago, Ill.
Collier, M. L.	Western & Atlantic	Atlanta, Ga.
Cooper, Chas. J.	C. S. & Mackinaw	East Saginaw, Mich.
Cooper, H. L.		4412 Wabash Ave., Chicago, Ill.
Cooke, Allen	C. & E., Ill.	Danville, Ill.
Cook, John S.	Georgia	Augusta, Ga.
Cory, C. H.	C. H. & D.	Lima, Ohio.
Cromwell, A. J.	Baltimore & Ohio	Baltimore, Md.
Cullen, Jas.	N. C. & St. L.	Nashville, Tenn.
Curran, Peter	N. Y., L. E. & W.	Bradford, Pa.
Cushing, G. W.		Chicago, Ill.
Dallas, Wilber C.		947 Desota Street, St. Paul, Minn.
Davis, Jas. A.	N. T. & Q.	Deseronto, Ont.
Davis, N. L.	Rutland	Rutland, Vt.
Deibert, F. W.	Cin., J. & M.	Marshall, Mich.
Dewson, E. H.	Union Pacific	Ellis, Kansas.
Divine, J. F.	W. & Weldon	Wilmington, N. C.
Dickson, G. L.		Dickson Locomotive Works, Scranton, Pa.
Dickson, J. P.		Dickson Locomotive Works, Scranton, Pa.
Dolbeer, Alonza	B. R. & Pittsburgh	Rochester, N. Y.
Domville, C. K.	Grand Trunk	Hamilton, Ont.
Downe, Geo.	Government	Sidney, N. S. Wales,
Downing, T.	El., Jol. & Eastern	Joliet, Ill.
Durrell, D. J.	Illinois Central	Chicago, Ill.
Eastman, A. G.		Sutton, Quebec.
Eddy, W. H.	Boston & Albany	Springfield, Mass.
Elliott, Henry		East St. Louis, Ill.

NAME.	ROAD.	ADDRESS.
Ellis, Matt	C., St. P., M. & O.	St. Paul, Minn.
Ennis, W. C.	N. Y., S. & W.	Wortendyke, N. J.
Ettinger, G. T.		New York.
Evans, Edward	Balt., Ohio & S. Western.	Chillicothe, Ohio.
Evarts, D. T.		Boston, Mass.
Fenwick. A.	G. B, W. & St. P.	Green Bay, Wis.
Ferguson, G. A.	Concord & Montreal	Lake Village, N. H.
Ferguson, Z. J.		
Ferry, F. J.	Louisville, St. Louis & Tex.	Henderson, Ky.
Finlay, L.	902 West 4th Street, Little Rock, Ark.	
Flahaven. W. M.	P. & W.	Allegheny, Pa.
Forsyth, Wm.	C., B. & Q.	Aurora, Ill.
Foster, W. A.	Fall Brook Coal Co., Corning, N. Y.	
Fowle, I. W.	Colorado Midland	Leadville, Col.
Fraser, T. A.	Wells & French Car Works, Chicago, Ill.	
Fuller, William	213 Kennard Street, Cleveland, Ohio.	
Galloway, A.	T. A. A. & N. M.	Owosso, Mich.
Garlock, W. H.	S., L. S. & E.	Seattle, Wash.
Garrett, H. D.	Pennsylvania	Philadelphia, Pa.
Garstang, Wm.	Ches. & Ohio	Richmond, Va.
Gates, W. G.		Salisbury, N. C.
Gentry, T. W.	Richmond & Danville	Richmond, Va.
George, Nathan M.		Danbury, Conn.
Gessler, Wm.	C., R. I. & P.	Trenton, Mo.
Gibbs, A. W.	Georgia Central	Savannah, Ga.
Gibbs, George	C., M. & St. Paul	Milwaukee, Wis.
Gilmour, W. L.	L. S. & M. S.	Elkhart, Ind.
Givan, F. A.	Ches. & Ohio	Huntington, W. Va.
Gordon, H. D.	Juniata Shops, Altoona, Pa.	
Gordon, Jas. T.	Concord	Concord, N. H.
Graham, Chas.	D., L. & Western	Scranton, Pa.
Graham, J. S.	L. S. & M. S.	Cleveland, Ohio.
Greatsinger, J. L.	D. & I. Range	Two Harbors, Minn.
Griffith, Fred B.	D., L. & Western	Buffalo, N. Y.
Griggs, A	New York & New England	Norwood, Mass.
Gugel, Daniel M.		Macon, Ga.
Hackney, Clem.	624 Washington St., Milwaukee, Wis.	
Hackney, George		Chicago, Ill.
Hackney, Herbert		Chicago, Ill.
Haggett, J. C	D. & A. Valley	Dunkirk, N. Y.
Haggerty, G. A.	New Brunswick	St. Johns, N. B.

NAME.	ROAD.	ADDRESS.
Hall, Don Diego	Government Railways	Santiago, Chili.
Hall, J. N.		Montgomery, Ala.
Haller, W. J.	Ches. & Ohio	Richmond, Va.
Ham, C. T.	Buffalo Steam Gauge Co.,	Rochester, N. Y.
Hamington, John	Central Pacific	Lathrop, Cal.
Hanson, C. F.	Grand Trunk	London, Ont.
Harding, B. R.	R. G. R. & A.	Raleigh, N. C.
Harrington, S. H.	C., C., C. & St. L.	Indianapolis, Ind.
Harris, Geo. D.	Richmond & Danville	Salisbury, N. C.
Harrison, W. H.	Baltimore & Ohio	Newark, Ohio.
Haskell, B.	Northern Pacific	Missoula, Mont.
Hatswell, T. J.	F. & P. M.	East Saginaw, Mich.
Hazelton, G. H.	R. W. & O.	Oswego, N. Y.
Hazlehurst, G. B.	Baltimore & Ohio	Baltimore, Md.
Hassman, Wm.	Ches. & Ohio	Huntington, W. Va.
Haynes, O. A.		St. Louis, Mo.
Hemphill, W. J.	Jack. South Eastern	Jacksonville, Ill.
Hendee, A.	Westinghouse Air Brake Co.,	Pittsburgh, Pa.
Henney, J. B.		Boston, Mass.
Heintzleman, T. W.	So. Pacific	Sacramento, Cal.
Hewitt, John	Union Pacific	Albina, Ore.
Hickey, John	M. W. S. & Western	So. Kaukauna, Wis.
Higgins, S.	N. Y. P. & O.	Meadville, Pa.
Hill, Jas. W.	Peoria & Pekin Union	Peoria, Ill.
Hinman, M. L.	Brooks Locomotive Works,	Dunkirk, N. Y.
Hodgman, S. A.	Lobdell Car Wheel Co.,	Wilmington, Del.
Hoffecker, W. L.	Central of New Jersey	Elizabethport, N. J.
Holman, W. L.	Penna.	Renovo, Pa.
Hudson, E. E.	C., C., C. & St. Louis	Cleveland, Ohio.
Hughes, E. W. M.	Rookery Building	Chicago, Ill.
Humphrey, A. L.	Colorado Midland	Colorado City, Col.
Irby, Chas.	K. C., F. S. & M.	West Memphis, Ark.
Jackson, O. H.	O. & Miss.	Vincennes, Ind.
Jacques, Richard	Copiapo, Chili	Boston, Mass.
Jeffery, E. T.	1919 Michigan Ave.,	Chicago, Ill.
Jennings, Wm	Mexican International	Piedras Negras, Mex.
Johann, Jacob	608 Phœnix Building,	Chicago, Ill.
Johns, C. T.		Cleveland, Ohio.
Johnson, J. B.	A. Midland	Helena, Ark.
Johnson, L. R.	Canadian Pacific	Vancouver, B. C.
Johnstone, F. W.		City of Mexico.
Joughins, G. R.	Norfolk Southern	Berkley, Va.

NAME.	ROAD.	ADDRESS.
Kamington, John	Southern Pacific	Lathrope, Cal.
Keeler, Sanford	F. & P. M.	East Saginaw, Mich.
Kiehner, John L	2341 E. York St., Philadelphia, Pa.	
Kiley, M. R.	St. Jo. & G. I.	St. Joseph, Mo.
Killen, W. E.	Nevada Central	Battle Mountain, Nev.
Kells, Leroy	P. C. & St. L.	Cincinnati, Ohio.
Kells, Ross	N. Y., L. E. & W.	New York.
Kimball, N. S.	M. & Northern	Green Bay, Wis.
Kinsey, J. I.	Lehigh Valley	Easton, Pa.
Lannan, Wm.	House of Representatives, Washington, D. C.	
Lape, C. F.	Wabash	Springfield, Ill.
Lape, J. K.	St. J., St. L. & S. F.	St. Joseph, Mo.
Lauder, J. N.	Old Colony	Boston, Mass.
Lavery, W.	N. Y., L. E. & W.	Susquehanna, Pa.
Leach, H. L.	1 Rollins St., Boston, Mass.	
Leeds, Pulaski	L. & Nashville	Louisville. Ky.
Leigh, F. J.	Canadian Locomotive Works, Kingston, Ont.	
Leonard, A. G.	N. Y. Central	New York City.
Lewis, W. H.	D. L. & Western	Kingsland, N. J.
Lewis, William H.	C. B. & Northern	La Crosse, Wis.
Lloyd, T. S.	Ches. & Ohio	Covington, Ky.
Losey, Jacob	Steam Forge Co., Louisville, Ky.	
Luttgens, H. A.	Rogers Locomotive Works, Paterson, N. J.	
Luttrell, J. W.	N. N. & Miss. Valley	Paducah, Ky.
Lythgoe, Joseph	Rhode Island Locomotive Works, Providence, R. I.	
Macbeth, James O.	West Shore	Buffalo, N. Y.
Mackenzie, John	N. Y., C. & St. L.	Cleveland, Ohio.
Maglenn, Jas.	Carolina Central	Laurenburgh, N. C.
Manly, Basil	A. & N. C.	Newberne, N. C.
Marshall, E. S.	St. L. A. & Tex	Pine Bluff, Ark.
Maver, A. A.	Grand Trunk	Stratford, Ont.
May, Edward	Intercolonial	Moncton, N. B.
McCreery, Frank	Dayton, Ft. Wayne & C.	Dayton, Ohio.
McCrum, J. S.	K. C., Ft. S. & G.	Kansas City, Mo.
McGrayel, John	C., R. I. & P.	Grand Junction, Ia.
McNaughton, Jas.	Wis. Central	Waukesha, Wis.
McNiven, P. C.	Canadian Locomotive Works, Kingston, Ont.	
McKenna, John	I. D. S.	Indianapolis, Ind.
Medway, John	Fitchburgh	Mechanicsville, N. Y.
Meehan, James	C., N. O. & T. P.	Ludlow, Ky.
Michael, J. B.	E. T., V. & Ga.	Knoxville, Tenn.
Mills, Stott	Lehigh & Hudson	Warwick, N. Y.

NAME.	ROAD.	ADDRESS.
Middleton, Harvey	Union Pacific	Cheyenne, Wy. Ter.
Midelton, Thomas	Government Railways	Sidney, N. S. W.
Millen, Thomas	New York City & N.	High Bridge, N. Y.
Miller, E. A.	N. Y., C. & St. L.	Conneaut, Ohio.
Minshull, E.	N. Y., O. & W.	Middletown, N. Y.
Mitchell, A.	Lehigh Valley	Wilkesbarre, Pa.
Monkhouse, H.	C., R. I. & P.	Horton, Kan.
Montgomery, Wm.	C. of N. J.	Manchester, N. J.
Moore, J. H.		Port Jervis, N. J.
Morrell, J. E.	C. R. I. & P.	Davenport, Ia.
Morris, W. S.	C. & W. Mich.	Grand Rapids, Mich.
Morse, G. F.	Portland Locomotive Works, Portland, Me.	
Mulligan, J.	Conn. River	Springfield, Mass.
Murphy, J. H.		Buffalo, N. Y.
Murphy, P. H.	St. L., A. & T. H.	East St. Louis, Ill.
Nichols, Edward	Brooks Locomotive Works, Dunkirk, N. Y.	
Noble, L. C.	H. & T. C.	Houston, Tex.
O'Brien, John	Richmond & Petersburg	Manchester, Va.
Olcott, H. P.		Coolidge, Kan.
Ortton, John	T., St. L. & K. C.	Delphos, O.
Pattee, J. O.	Great Northern	St. Paul, Minn.
Patterson, J. S.		Cincinnati, Ohio.
Paxson, L. B.	P. & Reading	Reading, Pa.
Peck, Peter H.	C. & W. I. Belt	Chicago, Ill.
Perry, F. A.	Cheshire	Keene, N. H.
Phelan, J. E.	Northern Pacific	Dickinson, N. Dak.
Pilsbury, Amos	Maine Central	Waterville, Me.
Pitkin, A. J.	Schenectady Loco. Works, Schenectady, N. Y.	
Place, T. W.	Illinois Central	Waterloo, Ia.
Player, John	A., T. & S. Fe.	Topeka, Kan.
Porter, Joseph S.	C., S. & C.	Sandusky, Ohio.
Prescott, G. H.	T. H. I. & St. L.	Terre Haute, Ind.
Pringle, R. M.	1101 N. Second Street, St. Louis, Mo.	
Purvis, T. B.	Boston & Albany	East Albany, N. Y.
Purvis, Jr., T. B.	Boston & Albany	East Albany, N. Y.
Quackenbush, A. W.	Chicago & Alton	Bloomington, Ill.
Quayle. Robert	C. & Northwestern	Clinton, Iowa.
Quinn, John A.	C. V. & C.	Mt. Carmel, Ill.
Ramsey, J. C.	Illinois Central	Water Valley, Miss.
Randolph, L. S.	Baltimore & Ohio	Baltimore, Md.
Ransom, T. W.	N. Y., L. E. & W.	Hornellsville, N. Y.

NAME.	ROAD.	ADDRESS.
Raynal, A. H.	Locomotive	Works, Richmond, Va.
Reed, W. T.	Chi., St. Paul & Kan. City	St. Paul, Minn.
Rennell, Thomas	Little Rock & M.	Argenta, Ark.
Renshaw, W.	Illinois Central	Chicago, Ill.
Reynolds, W. W.	C., St. L. & P.	Columbus, Ohio.
Rhodes, G. W.	C., B. & Q.	Aurora, Ill.
Richardson, E.	S. & Allegheny	Shenango, Pa.
Richardson, R. M.	Missouri Pacific	Little Rock, Ark.
Rickard, C. W.	Zapiga Ferro Caril	Zapiga, Chili.
Riley, G. M. D.	Sav., Fla. & Western	Savannah, Ga.
Robb, W. D.	L. & Nashville	Pensacola, Fla.
Roberts, E. M.	E. T., V. & Ga.	Atlanta, Ga.
Robertson, W. J.	C. Vermont	St. Albans, Vt.
Robinson, John	L. S. & M. S.	Buffalo, N. Y.
Ross, Geo. B.		Box 326, Buffalo, N. Y.
Rossiter, C. W.	Northern Pacific	Duluth, Minn.
Rutherford, Wm.	J. T. & K. W.	Palatka, Fla.
Sample, N. W.	D. & R. G.	Denver, Col.
Sanborn, C. A.		Carondelet, Mo.
Savage, R. W.	St. L., Ark. & Tex.	Tyler, Texas.
Schaeffer, Aug.	Maysville Water	Works, Maysville, Ky.
Schlacks, Henry	Illinois Central	Chicago, Ill.
Sedgwick, E. V.	Mexican National, Box 101,	San Luis Potosi, Mexico.
Selby, W. H.		Huntington, Ind.
Sellers, Morris		6 Ashland Block, Chicago, Ill.
Setchel, J. H.		Cuba, N. Y.
Shaver, D. O.	Pennsylvania	Pittsburgh, Pa.
Sheerer, E. P.	Des Moines Union	Des Moines, Ia.
Sheppard, F. L.	Pennsylvania	Altoona, Pa.
Short, W. A.	Central Vermont	Malone, N. Y.
Silvius, E. T.	J., S. A. & H. R.	St. Augustine, Fla.
Sitton, B. J.	Mexican National	Laredo, Texas.
Skinner, H. M. C.	New York Locomotive	Works, Rome, N. Y.
Small, H. J.	Southern Pacific	San Francisco, Cal.
Small, W. T.	Northern Pacific	St. Paul, Minn.
Smart, C. E.	Michigan Central	Jackson, Mich.
Smith, Allison D.	Government	New Port, Victoria.
Smith, F. C.	A., T. & S. F.	Topeka, Kan.
Smith, Howard M.		Alexandria, Va.
Smith, William	Boston & Maine	Boston, Mass.
Smith, W. T.	Newport News & Miss V.	Lexington, Ky.
Sprague, H. N.	Porter Locomotive	Works, Pittsburgh, Pa.
Stapf, F. M.		Mt. Carmel, Ill.

NAME.	ROAD.	ADDRESS.
elen, F.	Erie & Huron	Chatham, Ont.
ns, W. H.	Conn. River	Springfield, Mass.
iens, S. A.	Rhode Island Locomotive Works, Providence, R. I.	
ns, George W.	L. S. & M. S.	Cleveland, O.
art, O.	Fitchburg	Charlestown, Mass.
rd, F. A.	8 Dickinson street, Paterson, N. J.	
s, J. W.	Ohio & Miss.	Pana, Ill.
:, W. A.	L. E. & St. L.	Huntingburg, Ind.
e, James.	N. Central	Elmira, N. Y.
:r, A. L.	C. R. I. & P.	Stuart, Ia.
'an, A. W.	Illinois Central	Chicago, Ill.
ston, William	C., St. L. & P.	Indianapolis, Ind.
y, H.	Brooks Locomotive Works, Dunkirk, N. Y.	
S. A.	F. E. & M. V.	Missouri Valley, Ia.
:her, Thomas	D., L. & W.	Utica, N. Y.
ias, C. F.	Richmond & Danville	Alexandria, Va.
ias, W. H.	E. T., V. & Ga.	Knoxville, Tenn.
ias, W. J.	North P. Coast	Sausalite, Cal.
ipson, C. A.	Long Island	Richmond Hill, N. Y.
ipson, W. A.	M. H. & O.	Marquette, Mich.
·, William	Government	N. S. Wales.
:r, S. B.	C. W. & Mich.	Wabash, Ind.
nce, John	E. & T. H.	Evansville, Ind.
:lles, Henry	Westinghouse Air Brake Co., Pittsburgh, Pa.	
le, S. R.	Kentucky Central	Covington. Ky.
:r. Calvin G.	Phil., Wil. & Balt.	Wilmington, Del.
er, Charles E.	W. N. Y. & Pa.	Olean, N. Y.
:r, J. S.	Eames Vacuum Brake Co., New York.	
er, L. H.	Pitt. & L. Erie	Chartiers, Pa.
:ff, W. F.	C., C., C. & St. L.	Indianapolis, Ind.
ibly, A. W.	Old Colony	Taunton, Mass.
ibly, Fred. M.	Old Colony	Boston, Mass.
ibly, T. B.		Chicago, Ill.
n, F. F.	Unidos de la Habana	Habana, Cuba.
. H. A.	Charleston & Savannah	Savannah, Ga.
:hill, A. B.	B. & Albany	Springfield, Mass.
A.	W. N. Y. & Pa.	Buffalo, N. Y.
3rant, G. E.	Penna. & Northwestern	Bellwood, Pa.
William	Rookery Building, Chicago, Ill.	

NAME.	ROAD.	ADDRESS.
Wakefield, S. W.	C., R. I. & P.	Keokuk, Ia.
Walker, C. W.	S. & Roanoke	Portsmouth, Va.
Wall, E B.	P., C. & St. L.	Columbus, O.
Wallis, Herbert	Grand Trunk	Montreal, Can.
Wallis, Philip	C., B. & Q.	Beardstown, Ill.
Walsh, Thomas	Louisville & Nashville	Mt. Vernon, Ill.
Wanklyn, F. L	Grand Trunk	Montreal, Can.
Ward, C. F.	St. P. & D.	St. Paul, Minn.
Warren, Beriah	T., P. & W.	Peoria, Ill.
Warren, W. B.	2808 Lafayette avenue, St. Louis, Mo.	
Watts, Amos H.	C., J. & M.	Marshall, Mich.
Webb, F. W.	L. & N. W.	Crewe, England.
Webber, H. N.		
Weisgerber, E. L.	Baltimore & Ohio	Newark, O.
Wells, Reuben	Rogers Locomotive Works, Paterson, N. J.	
West, G. W.	N. Y., O. & Western	Middleton, N. Y.
Wheeler, M. C.	Central Iowa	Marshalltown, Ia.
White, A. M.	Schenectady Locomotive Works, Schenectady, N. Y.	
Whitlock, Joseph	N. H. & D.	Ansonia, Conn.
Whitney, H. A	Intercolonial	Moncton, N. B,
Wightman, D. A.	Pittsburgh Locomotive Works, Allegheny, Pa.	
Williams, C. G.	C. of N. J.	Communipaw, N. J.
Williams, R.	New York Locomotive Works, Rome, N. Y.	
Winslow, J. M.	Todd Machine Co., Tacoma, Wash. Ter.	
Wilson, G. F.	C., R. I. & P.	Chicago, Ill.
Wilson, John	Union Pacific	Omaha, Neb.
Wilson, William		Bloomington, Ill.
Worcester, F. E.	D., S., S. & A.	Marquette Mich.

ASSOCIATE MEMBERS.

NAME.	ROAD.	ADDRESS.
:s, D. L.		Rookery Building, Chicago, Ill.
F. W.		27 School street, Boston, Mass.
y, M. N.		145 Broadway, New York.
›n, Alex.		Niles Tool Works, Hamilton, O.
John A.		96 Fulton street, New York.
John W.		Glenn Building, Cincinnati, O.
L. F.		307 Grove street, Jersey City, N. J.
F. B.	Bement & Miles, Philadelphia, Pa.	
roy, L. R.	Suburban Rapid Transit Co., New York, N. Y.	
Thomas		915 Ridge street, Philadelphia, Pa.
ir, Angus		Morse Building, New York.
, John Y.		Doylestown, Pa.
, W. A.		Rookery Building, Chicago, Ill.
lock, Jerome		25 Elizabeth street, Worcester, Mass.

HONORARY MEMBERS.

lge, G. A.		Charlestown, Mass.
ıings, S. A.		Dorchester, Mass.
s, Isaac		345 Walnut street, Philadelphia, Pa.
Wilson		Springfield, Mass.
J. M.	Central Vermont	St. Albans, Vt.
e, C. R.		Terre Haute, Ind.
ı, P. J.		Taunton, Mass.
:ic, J. W.		Waterville, Me.
rds, George		14 Auburn street, Roxbury, Mass.
son, W. A.		Hamilton, Ont.
ly, James		Cleveland, O.
pson, John		137 Webster street, East Boston, Mass.
e, H. A.		256 First avenue, Minneapolis, Minn.
, J. L.		Danville, Ill.
ms, E. H.		Baldwin Locomotive Works, Philadelphia, Pa

CONSTITUTION AND BY-LAWS,

AS ESTABLISHED BY THE TWENTY-FIRST ANNUAL CONVENTION, AND AMENDED AT THE TWENTY-THIRD CONVENTION.

ARTICLE I.

NAME.

The name of this Association shall be the AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

ARTICLE II.

OBJECTS OF ASSOCIATION.

The objects of this Association shall be the advancement of knowledge concerning the principles, construction, repair and service of the rolling-stock of railroads, by discussions in common, the exchange of information, and investigations and reports of the experience of its members; and to provide an organization through which the members may agree upon such joint action as may be required to give the greatest efficiency to the equipment of railroads which is entrusted to their care.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The following persons may become active members of the Association, on being recommended by two members in good standing, signing an application for membership and agreement to conform to the requirements of the Constitution

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SEC. 3. The Executive Committee shall receive, examine and approve before public reading, all communications, papers and reports on all mechanical and scientific matters; they shall decide what portion of the reports, papers and drawing shall be submitted to each convention and what portion shall be printed in the Annual Report.

SEC. 4. Three members shall constitute a quorum for the transaction of business.

ARTICLE VII.

ELECTION OF OFFICERS.

SEC. 1. The officers of the Association shall be elected by ballot separately without nomination at the regular meeting of the Association held in June of each year. A majority of all votes cast shall be necessary to an election and elections shall not be posponed.

SEC. 2. Two tellers shall be appointed by the President to conduct the election and report the result.

ARTICLE VIII.

AUDITING COMMITTEE.

SEC. 1. At the first session of each annual meeting an Auditing Committee, consisting of three members not officers of the Association, to be nominated by any member who does not hold office, shall be elected in the same way as officers are voted for. This Auditing Committee shall examine the accounts and vouchers of the Treasurer and certify whether they have been found correct or not. After the performance of this duty they shall be discharged by the acceptance of their report by the Association.

COMMITTEE ON SUBJECTS FOR INVESTIGATION AND DISCUSSION.

SEC. 2. At each annual meeting the President shall appoint a committee whose duty it shall be to report at the next annual meeting subjects for investigation and discussion, and if the subjects are approved by the Association the President, as here-

the Association and deliver the same to the Treasurer, taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association; to receive all bills and pay the same, after having the approval of the President; to deliver all bills paid to the Secretary at the close of each meeting, taking a receipted statement of the same and to keep an accurate book account of all transactions pertaining to his office.

ARTICLE VI.

EXECUTIVE COMMITTEE.

SEC. 1. The Executive Committee shall exercise a general supervision over the interests and affairs of the Association, recommend the amount of the annual assessment, to call, to prepare for, and to conduct, general conventions, and to make all necessary purchases, expenditures and contracts required to conduct the current business of the Association, but shall have no power to make the Association liable for any debt to an amount beyond that which at the time of contracting the same shall be in the Treasurer's hands in cash, but not subject to prior liabilities. All expenditures for special purposes shall only be made by appropriations acted upon by the Association at a regular meeting.

BOSTON FUND.

SEC. 1. The Executive Committee shall be a Board of Trustees having the care of the Boston Fund. They shall appoint its custodian and give directions as to the investment of both its principal and interest; but they shall have no power to expend any portion of the fund unless authorized by a majority of the members present at an annual meeting and then only after due notice in writing, of a motion to expend such money has been given at the preceding annual meeting. A report of the state of this fund shall be made at each annual meeting, by the Executive Committee.

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COMMITTEE ON SUBJECTS FOR INVESTIGATION AND DISCUSSION.

SEC. 2. At each annual meeting the President shall appoint a committee whose duty it shall be to report at the next annual meeting subjects for investigation and discussion, and if the subjects are approved by the Association the President, as here-

inafter provided, shall appoint committees to report on them. It shall also be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall determine whether such questions are suitable ones for discussion, and if so, they shall so report them to the Association.

COMMITTEES ON INVESTIGATION.

Sec. 4. When the Committee on Subjects has reported, and the Association approved of subjects for investigation, the President shall appoint special committees to investigate and report on them, and may authorize and appoint a *special* committee to investigate and report on any subject which a majority of the members present may approve of.

ARTICLE IX.

AMENDMENTS.

Sec. 1. This Constitution may be amended at any regular meeting by a two-third vote of the members present, provided that written notice of the proposed amendments has been given at a previous meeting at least six months before.

BY-LAWS.

TIME OF MEETING.

I. The regular meeting of the Association shall be held annually on the third Tuesday in June.

HOURS OF SESSION.

II. The regular hours of session shall be from nine o'clock A. M. to two o'clock P. M.

PLACE OF MEETING.

III. "Places for holding the Annual Convention may be proposed at any regular meeting of the Association. Before the final adjournment the places proposed shall be submitted to a vote of the members, and within six months thereafter the Executive Committee shall select a place from the three which have received the highest number of votes."

QUORUM.

IV. At any regular meeting of the Association fifteen or more members entitled to vote shall constitute a quorum.

ORDER OF BUSINESS.

V. The business of the meetings of this Association shall, unless otherwise ordered by a vote, proceed in the following order:

1st. Opening Prayer.
2d. Calling the roll.
3d. Acting on the minutes of the last meeting.
4th. Address by the President.
5th. Reports of Secretary and Treasurer.
6th. Assessment and announcement of annual dues.
7th. Election of Auditing Committee.

8th. Unfinished business.
9th. New business.
10th. Reports of committees.
11th. Reading of papers and discussion of questions propounded by members.
12th. Routine and miscellaneous business.
13th. Election of officers.
14th. Adjournment.

QUESTIONS FOR DISCUSSION, SPECIAL ORDER OF.

VI. Unless otherwise ordered, the discussion of questions proposed by members shall be the special order from 12 o'clock M. to 1 P. M. of each day of the annual meeting.

DECISIONS.

VII. The votes of a majority of the members shall be required to decide any question, motion or resolution which shall come before the Association unless otherwise provided.

DISCUSSIONS.

VIII. No patentees or their agents shall be admitted in the meetings of the Association for the purpose of advocating the claims of any patent or patentee, unless by unanimous consent.

IX. No member shall speak more than twice in the discussion of any question until all the other members who want to speak and have not been heard have spoken.

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AMERICAN RAILWAY
MASTER MECHANICS' ASSOCIATION.

GENERAL INDEX

OF THE

ANNUAL REPORTS

FROM THE FIRST TO THE TWENTY-THIRD
REPORT INCLUSIVE (1868 TO 1890).

PREPARED BY

ANGUS SINCLAIR,
SECRETARY.

NEWARK, N. J.:
ADVERTISER PRINTING HOUSE,
1890.

At a meeting of the Executive Committee of the American Railway Master Mechanic's Association held at Old Point Comfort, Va., on June 17, 1890, a resolution was adopted directing the Secretary to prepare and publish a general index of all the Annual Reports of the Proceedings of the Association. This volume has been prepared in obedience to that resolution. In doing the work, I have distinguished reports, papers, discussions, etc., by the terms which indicate their contents, and in doing this it was necessary in many instances to depart from the captions found in the reports.

ANGUS SINCLAIR, *Secretary.*

REPORTS.

The Italic numbers indicate the number of the Report and the Roman numbers indicate the page.

PAPERS.

ILLUSTRATIONS.

DISCUSSIONS.

MISCELLANEOUS.